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The IJISPM publishes leading scholarly and practical research articles that aim to advance the information systems management and project management fields of knowledge, featuring state-of-the-art research, theories, approaches, methodologies, techniques, and applications.

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Editorial

The mission of the *IJISPM - International Journal of Information Systems and Project Management* is the dissemination of new scientific knowledge on information systems management and project management, encouraging further progress in theory and practice.

It is our great pleasure to bring you the fourth number of the eleventh volume of IJISPM. In this issue readers will find important contributions on success in project management, agile software development approach, competence of project management professionals and project management practice on information systems projects.

The first article, "Successful projects or success in project management - are projects dependent on a methodology?", is authored by Henrik J. Nyman and Anssi Öörni. The purpose of this article is to bridge two seemingly disparate views of project management: proponents of project management methodologies promote a view where a standard set of predefined project practices guarantee project success, while a contingent view of projects suggests that project management needs to be adaptive to project actuality and context. The aim is to understand how these different forms of managing projects impact project success. The authors propose a framework to determine the right amount of discretion in a project, highlighting which project management methodology is suited for the work at hand or whether discarding methodology altogether is more likely to lead to project success.

The title of the second article is "Agile software development approach for 'ad-hoc' IT projects", which is authored by Michal Kuciapski and Bartosz Marcinkowski. This work delivers a comprehensive software development approach for both academic and commercial Information Technology (IT) projects effectuated by teams that are hampered by significantly unsystematic participation of project members and mercurial internal communication. The nature of 'ad-hoc' projects imposes another level of difficulty in terms of both managing the conduct of such a project and ensuring the quality of the end product. Multicyclic action research enabled a gradual adaptation of the Scrum approach to support such project conditions. This study introduces major alterations to Sprint implementation and minor enhancements within the documentation process to streamline knowledge sharing among Development Team members. The proposed approach is suitable not only for carrying out software development initiatives that rely heavily on the skills of external experts and/or volunteers. It also supports traditional Scrum teams that seek to reduce their exposure to risk arising from organizational changes.

The third article, authored by Nelson Jose Rosamilha, Luciano Ferreira da Silva and Renato Penha is entitled "Competence of project management professionals according to type of project: a systematic literature review". Globalization and economic volatility changed the dynamics of production chains, which required new organizational arrangements from companies, leading them to projectization. Additionally, project professionals are managing increasingly complex projects, which demand an extensive and specific set of competences. In this context, this paper aims to identify the competences of project professionals by project type. A systematic literature review was carried out. As a result, this research identified 173 competences distributed in 14 different project types; some competences have a greater significance for a given project type.

"Information systems project management practice in Portugal - looking at the past to perspective the future" is the fourth article and is authored by Nilton Takagi, Carlos Ueslei Rodrigues de Oliveira, Fernando Escobar, António Trigo and Luis Silva Rodrigues. The study of Information Systems Project Management (ISPM) practice is fundamental for developing knowledge in this field. Over the past few years, several studies have been conducted in organizations by professionals and academics to identify approaches, processes, tools, and techniques, among other relevant aspects of project management practice. The use of these practices can be related to various factors, such as trends in the world of work or even the cultural context. In this way, an insight into the context of a given region can support actions to

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improve ISPM practice and raise success rates in Information Systems (IS) projects. This paper presents the results of a systematic literature review that seeks to synthesize how project management on IS is practiced in Portugal and identify opportunities for developing the project management body of knowledge.

We would like to take this opportunity to express our gratitude to the distinguished members of the Editorial Board, for their commitment and for sharing their knowledge and experience in supporting the IJISPM.

Finally, we would like to express our gratitude to all the authors who submitted their work, for their insightful visions and valuable contributions.

We hope that you, the readers, find the International Journal of Information Systems and Project Management an interesting and valuable source of information for your continued work.

The Guest Editor,

Carlos Sousa Pinto, *University of Minho, Portugal*

Carlos Sousa Pinto received the BSc in Informatics Engineering ("*Engenharia de Sistemas e Informática*") from the University of Minho, Portugal, in 1988, the MSc degree in Management Information Systems ("*Informática de Gestão*") from the Universidade do Minho, Portugal, in 1999, and the Ph.D. degree in Sciences and Technology of Communication ("*Ciências e Tecnologia da Comunicação*") from the University of Aveiro, Portugal, in 2007. He is a professor at the Department of Information Systems, University of Minho, and a researcher at the ALGORITMI/LASI center. His current research interests include Domain Ontologies and Information Systems. He has several publications in academic conferences and journals, participation in academic exam juries, and student supervision. He is the former director of the Information Society Course (University of Minho and the Portuguese Military Academy, 11th edition). He is also the former director of the Master in Information Services course. He was the responsible researcher for the DeGóis project from 2014 to 2017.

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Successful projects or success in project management - are projects dependent on a methodology?

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Abstract:
The purpose of this paper is to bridge two seemingly disparate views of project management: proponents of project management methodologies promote a view where a standard set of predefined project practices guarantee project success, while a contingent view of projects suggests that project management needs to be adaptive to project actuality and context. Our aim in this paper is to understand how these different forms of managing projects impact project success. We investigate projects through a lens of discretion, defined as autonomy in the project team to adapt the project to its context as opposed to a reliance on a pre-defined set of rules for project management. We also look at the role of exploration, that is, whether the project focuses on the development of new knowledge, or whether the focus is on furthering existing competences. Based on our analysis, we propose a framework to determine the right amount of discretion in a project, highlighting which project management methodology is suited for the work at hand or whether discarding methodology altogether is more likely to lead to project success.

Keywords:
agile project management; traditional project management; contingency theory; discretion; exploration; exploitation.

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1. Introduction

Project work is often governed by standard work practices defined in a project methodology. Numerous studies and books advocate the use of these standardized ways of working for a successful project [1]-[6]. Project success, in turn, has traditionally been defined with the help of the "iron triangle" of efficiency, exemplified as adherence to budgetary constraints, a timeline, and the goals specified for the project. Despite the alleged panacea of project methodologies and standard practices, project success rates remain low [3],[7],[8]. Clearly, project methodologies do not work equally well in all projects.

Instead, contingency theory posits that an emergent project management style is needed to cope with the unique features and complexities of projects, thereby adapting the project to its organizational context [9]-[13]. This supports a notion of discretion, whereby project managers have the autonomy to independently decide how work should be organized. Naveh [14] defines discretion as spontaneity and breaking the rules of a methodology, as opposed to formality, where pre-defined processes govern project work.

In this paper, we review ways to determine which project methodology suits a given project type, particularly relating to traditional 'waterfall' methods and iterative agile methods. Both have been used in our case company. We also review studies that address the suitability of different project methodologies. These studies typically work with an assumption that a pre-defined methodology is needed for project success [3],[15],[16]. The more provocative question we seek to answer is whether methodology is needed at all, or whether it is sufficient that management practices in the line organization are applied in a temporary project context. This would assume that projects are better off with full discretion. We develop a framework to understand the characteristics of projects that benefit from a formal methodology and projects that benefit from discretion. Unlike previous ways to categorize projects based on, for example, complexity, uncertainty, and dynamism [10],[12],[16], we examine the role of exploration in projects [17]. We thus turn to organizational learning, looking at whether new competences are developed in the project, or whether the project relies on existing competences [18].

Earlier research on project contingency has focused on the project characteristics that call for emergent project management [10]-[12]. Similarly, research that advocates standardized project management list several factors why project management methodologies work [1]-[3],[5]. Alternatively, some studies maintain that projects benefit from altering between formality and discretion [14]. Our findings address a gap in literature by simultaneously examining project discretion and a view that promotes strict adherence to a formal methodology [19]. We address this tension by viewing project management as a continuum from established project management methodologies to fully emergent project management. At the same time, we move from a descriptive to a prescriptive study, detailing principles for when to adapt what kind of project management. In other words, we determine when a contingent view and discretion is advisable, and when predefined practices and formality should be applied for project success.

In the next section, we will examine relevant literature on the subject at hand. Section 3 outlines the context of our study, and the methods we used to analyze our empirical data. Section 4 details the results, followed by Section 5 which discusses the results considering previous literature. In the last section, we present key conclusions, limitations of the study, and recommendations for further research.

2. Project management and project actuality

Typical for most definitions of projects is the focus on two dominant traits: the project is a temporary endeavor, and it is unique in nature [4],[10],[20],[21]. Rather than focusing only on the "iron triangle", project success is increasingly also defined through stakeholder satisfaction [21]-[23]. This implies that success is "in the eyes of the beholder" [21, p. 768]. As such, project success is multi-faceted rather than limited to predefined metrics.

In this section, we review previous literature with respect to key elements of our framework. We discuss project methodologies as well as contingency theory in a project management context. Further, we identify discretion and

exploration as key dimensions in projects. We also identify additional concepts, which we later use as control variables when we empirically test our framework.

2.1 Project methodologies

Project work often adheres to a set of rules. Ways of working are defined in a project management methodology and formality is strong. Joslin and Müller [13] outline processes, tools, techniques, methods, capability profiles, and knowledge areas as the building blocks of a project methodology. In other words, the methodology is a comprehensive toolkit that governs many, if not most, aspects of project work. The methodology is presented as proven good practice, implying that adherence to the outlined practices will result in well-run, effective projects, often stressing the universal applicability of the methodology in question [4],[6,],[15].

One underlying assumption of project research and practice is the plan-act-control cycle, whereby plans forms the basis of activities that are monitored for quality [24],[25]. This view has also been criticized. The agile manifesto, originating in software development but widely quoted in project management in general, exemplifies a shift of focus [26]. It states that, for example, "responding to change" is more important than "following a plan". In this view of projects, social interaction in the temporary organization is more important than planning of activities. As such, iterative planning, frequent customer feedback, and incremental steps lie at the core of agile project management (APM), whereas traditional project management (TPM) relies on one sequential plan-act-control cycle where customer feedback is gathered at the end of the project [27]. However, *any* project methodology relies on an assumption that certain pre-defined ways of working lead to project success. Further, APM merely breaks down the plan-act-control cycle to smaller entities. In practice, the cycle is reiterated several times throughout the project [3],[19].

2.2 Selecting a methodology for a successful project

APM's "rise to fame" has been rapid in recent years. For example, the latest edition of the Project Management Body of Knowledge [4] contains several additions covering agile practices. Practitioners and researchers alike stress that APM leads to higher success rates compared to traditional methods [3],[28]. So, does this mean that APM is the (only) way forward? It would appear there is more to the story: project success rates remain low, despite the prevalence of APM [7]. Overall, studies suggest that the benefits of APM are highest when there is uncertainty regarding how to achieve the project's goals [15],[29],[30], or when environmental dynamism is high, that is, there are frequent changes in the project's operating environment [16],[31]. Yet with growing support for APM, recent studies that advocate the use of TPM are hard to find. All-in-all, it would seem a shift has occurred, whereby APM is deemed suitable for most projects.

Studies have looked at structural complexity as a key dimension to consider when selecting project methodology. Structural complexity grows with the size, interconnectedness, and number of elements in a project [12],[20],[32],[33]. However, previous studies paint a somewhat contradictory picture regarding how structural complexity should be handled, some advocating APM [20],[32], and some declaring traditional methods unsuitable [16],[34]. In contrast, Shenhar and Dvir [12] conclude that the need for formality grows with structural complexity. Indeed, there are studies pinpointing specific challenges with APM, particularly in relation to managing interdependencies [35],[36]. A pertinent study by Paasivaara *et al.* [37] notes challenges with, for example, cross-site teams, integrations, and a common backlog in agile projects. As such, growing structural complexity might create challenges in agile projects. In summary, growing uncertainty and dynamism should drive the adoption of APM, whereas there are contradictory findings regarding structural complexity and project methodology.

Despite their promise, there is ambiguity on whether any given methodology can be universally considered the right approach to project management [38]. Several scholars have put forward that project management needs to consider organizational context and the actuality of projects (for an overview, see Hanisch and Wald [9]). This view of projects has garnered significant interest with studies advocating a contingent approach to project management based on, for example, complexity [10] and uncertainty [12],[39]. Some also promote a view where elements from methodologies are selectively used depending on prevailing circumstances [13]. All-in-all, a contingency view of projects assumes that

organizational context beyond that of the project is considered when determining how the project should be managed. Next, we will examine what this means in practice.

2.3 Discretion in project work

Tatikonda and Rosenthal [40, p. 403] define discretion as autonomy in the project team to "meet emerging circumstances", as opposed to formality that assumes pre-defined rules, processes, and structures for the project [19]. According to Naveh [14], discretion is about breaking rules and structures in the face of a volatile environment. However, discretion does not imply that planning and control are absent, but rather that project practices are developed "on the fly" as opposed to being governed by a pre-defined process or template.

Previous research indicates that development projects benefit from both formality and discretion [14],[40],[41]. APM has been portrayed as a solution to this conundrum, allowing for structure and efficiency while at the same time promoting flexibility and iteration [3],[21]. This would imply that APM has a built-in mechanism to allow for a degree of discretion, despite the formality of a methodology. In practice, APM allows for adaptability and learning by splitting the plan-act-control cycle to smaller entities.

2.4 Exploration and the uniqueness of projects

Exploration refers to the acquisition of new knowledge in an organization as opposed to exploitation, the utilization of existing competences [17],[18]. Conceptually, exploration has been linked to innovation [17]. However, subsequent research has divided innovation to two types: exploitative incremental innovation and exploratory radical innovation, the former concerned with further development of existing competences and the latter with the development of completely new ideas [42]. Given that projects are unique and drive for change, one could argue that innovation lies at the core of the project's task. However, many projects clearly exploit existing competences while other projects seek entirely new solutions [39]. In other words, while 'uniqueness' might refer to innovation, it can be of both the exploitative and exploratory kind. In addition to supporting the development of new competences in projects, exploration can also act to mitigate negative effects of project uncertainty and dynamism [39]. In other words, new competences are needed when the path to the project's goal is unclear, or when the project environment undergoes significant changes. So, how can exploration in projects be enabled? Lenfle [43, p. 477] notes that exploratory innovation in a project requires a "fundamental shift in project management methodology" from a traditional, instrumental view of the project. Similar conclusions are presented by McGrath [44] and Shenhar *et al.* [45], noting that less oversight and a contingent view of projects are needed for exploration.

2.5 Combined lessons

We have examined previous literature regarding project management methodologies, discretion, and exploration in projects. Figure 1 summarizes the relationship between these constructs. In essence, we posit that a high degree of discretion corresponds to a contingent view of projects. This emergent project management style allows project work to be adapted to project actuality. A high degree of discretion also acts to enable exploration in the project. On the other side of the continuum, TPM relies on a high degree of formality and low discretion, while prohibiting high exploration. APM, while still reliant on a degree of formality, allows for more discretion, thus also supporting exploration to a higher degree. In effect, this creates a continuum of effective project management, which is tied to the level of exploration in the project.

Next, we will empirically test this framework. Considering the contradictory findings regarding structural complexity, we will also look at this project aspect in more detail. Given that a high degree of discretion and exploration mitigate the effects of project uncertainty and dynamism, we will not investigate these aspects further.

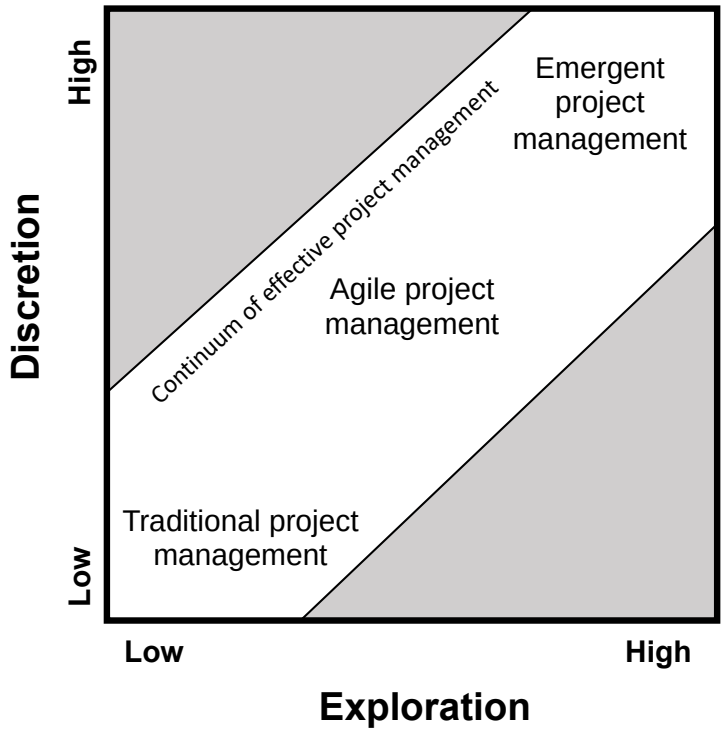

Figure 1. Relationship between discretion, project management, and exploration

3. Method

3.1 Interview data

In this paper, we examine different projects, how they were managed, and whether they were perceived as successful. In our analysis, we subscribe to a view of project success based on stakeholder satisfaction [21]-[23]. Our findings build on interviews with 32 project professionals and their managers at Nokia, an international telecommunications company (see Appendix A). The projects we examine varied in size and complexity, and they were managed with TPM, APM, or with full discretion for the project team (see Appendix B).

The sampling was purposive, including people who worked in projects and people who have switched from managing projects to managing teams (and project managers). As such, all our interviewees had experience in managing projects. Many of the projects investigated in this study also involved Nokia's suppliers. As such, we opted to interview supplier representatives from one of Nokia's largest partners (interviews number 14, 18, and 19 in Appendix A). The interviews were semi-structured; the central themes in the interviews centered around successful and unsuccessful projects, and the nature of exploration in projects. As the term 'exploration' is academic in nature, the word innovation was used in the interviews when referring to the process of seeking new knowledge. Each informant was asked to recall both successful and unsuccessful projects throughout their career and reflect on the role of innovation in said projects.

Data analysis was conducted in two steps. First, we did an inductive analysis of the interviews, starting with open coding [46]. After this, we gradually refined the coding categories to generate a conceptual model. To validate and extend the model, we conducted a qualitative comparative analysis [47],[48].

3.2 Context

At the time of the interviews, Nokia was a full-blown telecommunications company, offering mobile phones as well as telecommunications infrastructure. Since then, Nokia has shifted focus to only infrastructure. The projects that were discussed in the interviews concerned information systems (IS) development and product development. All product development projects involved both software and hardware development. Many of the IS projects concerned the implementation of standard IT solutions, such as Enterprise Resource Planning (ERP), advanced planning and scheduling (APS), or various data management or data exchange solutions.

The formal approach to project management at Nokia has followed a similar path to many other high-tech companies: projects that were organized according to traditional waterfall methods have taken an agile form [28],[37]. At the time of the interviews, Nokia was transitioning from an internal project management methodology to APM. The internal methodology was a milestone-based, waterfall methodology largely built around practices outlined in earlier editions of the Project Management Body of Knowledge [4].

3.3 Data analysis

The data collection stretched over a period of 18 months. The interviews were transcribed and coded, starting with open coding [46]. After this, the coding results were discussed, and a common set of categories were formed. The interviews and memos were re-read, focusing on one category at a time, resulting in redefined subcategories, and adding of new data to existing categories. New categories were created if there was need for it; a practice similar to the principle of constant comparison was present throughout the analysis [46]. In the final step, linkages between the categories were created.

Previous literature was read throughout the process, but the role of previous research for comparison was especially important in the later stages of the analysis. The categories often emerged in discussions between the authors, and whenever a new coding category was formed, previous literature helped in refining and defining the category further. The final categories are outlined in Section 4.4. Once the conceptual model was ready, we proceeded with a separate step to validate the model.

3.4 Validating and extending the model using qualitative comparative analysis

We used Qualitative Comparative Analysis (QCA) to validate the result of the interview coding [47],[48]. In addition, the QCA was designed to account for alternative explanations to project success, such as structural complexity affecting the outcome. QCA applies Boolean algebra and Quine's minimization algorithm to find the most parsimonious combination of antecedent variables capable of explaining an outcome variable. Due to the exponential growth of computing time, the method is most feasible when the number of cases is below 50 and the number of conditions (i.e., antecedent variables) is less than 12. In our analysis, we had 30 cases (i.e., projects listed in Appendix B). Five projects had to be excluded from the QCA due to incomplete data on some of the variables. In other words, the interviews contained insufficient information to assess specific variables. We defined seven antecedent Boolean variables affecting project success. These were based on previous literature, findings from the interview analysis, and characteristics in the data:

- Traditional project management;
- Agile project management (variable name 'A');
- Full discretion (B);
- High exploration (C);
- High structural complexity (D);
- Holistic architecture (E);
- Successful internal sales (F).

The first variable (traditional project management) was eventually excluded from the QCA as the second variable (agile project management) provided all necessary data. In practice, these variables contained opposite values and, thus, duplicate information. The number of cases (i.e., projects) is not directly tied to the number of interviews. Some informants referred to several projects, whereas some talked about projects in general without recalling a specific project.

We had clear criteria for assessing any given variable. Starting with the type of project management, some informants clearly indicated whether the project was milestone-based or agile. In other cases, we made the assessment based on how the informant described the project. One such example is when informants described projects having autonomy and a high degree of empowerment; project discretion was high. Some informants also described temporary undertakings as "not being projects". Given an organizational context that relied heavily on project methodologies, we believe some informants linked the definition of a project to the presence of a methodology. In line with the definition in this paper, we opted to classify these undertakings as projects with full discretion.

The role of exploration was determined based on the focus of the project. If, for example, the project concerned implementation, maintenance, or upgrades, we deemed that the focus was on exploiting existing competences. In contrast, some projects clearly aimed at developing new competences; we used the notion of exploratory innovation to guide coding of these cases [42].

Projects with high structural complexity always involved multiple organizational sub-units or partners where each entity had a big role in ensuring the success of the project. Typically, this resulted in multiple elements such as processes, partners, information systems, or product modules that needed to be combined in the project [12],[20],[32].

The last two variables, 'holistic architecture' and 'successful internal sales' were added because there were instances of project failure reported to us that did not fit any of the other antecedent variables. Projects 28 and 31 (see Appendix B) exhibited a lack of a holistic architecture. These were structurally complex new product development projects with hundreds of people working in smaller teams responsible for different product modules. Our informants described significant challenges with how interdependencies were managed. As such, a lack of 'holistic architecture' denotes a failure to manage structural complexity. Project 10 developed entirely new technology for mobile phones. However, at the time, no product team was willing to take the new technology into use. This was coded as a lack of 'successful internal sales', a challenge present also in some other projects.

3.5 QCA steps

We tabulated our data into a truth table (see Appendix B) composed of the outcome variable (project success) and seven antecedent variables. All antecedent conditions for the project outcome were coded as binary Boolean variables. This tabulation offers a useful way to represent variations in discrete data elements that underlie structured QCA. It also allows for systematically building an explanation, as opposed to an interpretation based on selected source text excerpts [49].

Next, we conducted the analysis using the Tosmana v1.1 QCA Excel Add-In [50]. We included six out of our seven antecedents in the analysis because of the duplicate information in the first variable (TPM). As a shorthand notation, we refer to the antecedent variables using upper case and lower-case letters to denote presence and absence of a project quality.

Our truth table was sparsely populated, as is usual, with only 19 causal conditions out of the theoretically possible 2^6 = 64 combinations of values. Frequently there are no instances of some configuration – a challenge known as a "problem of limited diversity" [51]. Often, though, such "remainder" rows represent cases that are theoretically unfeasible. Remainder rows can be used during the analysis as simplifying assumptions to reduce combinations of causal conditions [52]. We followed this approach in our analysis.

In the final QCA step, programmatic simplification of the truth table produces *prime implicants*. These are combinations of causal conditions that account for at least one positive instance of the outcome (see the prime implicant

chart in Appendix B). The prime implicants are further simplified to an equation that represents the causal conditions producing a given outcome.

The prime implicants in Appendix B contain some redundancy: only three of the six prime implicants cover a unique causal condition that needs to be included in a final reduced equation. The final reduced equation for project success combines these prime implicants with a fourth one:

O = abc + ACE + BCF + cd

As noted, upper case letters represent a condition that is present while lower case letters represent its absence. The letters represent the antecedent variables listed in Section 3.3, starting from 'agile project management' (that also details whether TPM was used or not). Separate conditions independently producing an outcome is represented with the logical OR operator '+'. These separate conditions are thus alone sufficient for the outcome (project success). Conditions that combined produce a given outcome are represented by writing the symbols for the conditions together. In such cases, all conditions are necessary, and no condition alone is sufficient for the outcome. We examine the reduced equation for project success further in Section 4.5 (results).

4. Results

4.1 Discretion in projects

Project management in our case company evolved from an empowered mode where people in the project were responsible for developing ways of working, towards a mode where the organization had an all-encompassing project management methodology. This formalization of ways of working, over time, was a recurring theme in the interviews. Some viewed this as a natural and positive development, whereas others saw it as less valuable for the success of the project. However, there were exceptions to how projects were run. Project discretion is well illustrated by one informant's response to the IT department's request for a formal review of the IT architecture:

> *Can we go with [name of IT tool]? I thought it had a funny name. In a way, this was very shocking [to them]. (Interview #6)*

The project selected the IT solution proposed by our informant and completed the project successfully in record time. The work in the project deviated from practices outlined in a methodology, focusing less on selecting the best possible IT solution and more on quickly getting the job done. Ultimately, formality and discretion were key coding categories in the interview analysis. Table 1 provides examples of formal practices linked with certain project methodologies, as well as examples of discretion where the project deviated from a project methodology.

Table 1. Examples of formality and discretion

Formality	**Discretion**
▪ Project plans with work-breakdown-structures ▪ Project phases, milestones ▪ Steering group meetings ▪ Business case calculations ▪ Project budgets ▪ Scope specifications ▪ Project roles and responsibilities, e.g., communication specialist, change management specialist, quality manager ▪ Concept descriptions (detailing business processes and high-level IT solution) ▪ IT architecture documentation ▪ Communication plans	▪ Picking and choosing elements of different project management methodologies for the same project ▪ "Fluid action plans" ▪ Decision making without steering group approval, a "just-do-it approach" ▪ Allocation of work "through personal contacts" ▪ Problem solving by re-allocating roles and responsibilities, "just getting these four guys to solve the problem" (as opposed to formal project planning) ▪ Less emphasis on planning, more acting "in the moment" ▪ Accountability in the line organization (as opposed

Formality	Discretion
▪ Change management plans ▪ Service level agreements ▪ SCRUM ▪ Demo sessions ▪ Portfolio management practices ▪ Exit criteria	to in the project organization) ▪ No "cast-list" (roles and responsibilities) in the project ▪ "Empowering people to do any changes they can"

4.2 Exploration in projects

Exploration was another key theme in our interviews. When tying innovations to projects, some informants described how new ways of working or entirely new products was brought about by the project. At the same time, some informants saw no link between innovation and project work. This resulted in two categories of projects, low exploration projects and high exploration projects. Examples of these are listed in Table 2.

Table 2. Examples of low- and high exploration projects

Low exploration projects	High exploration projects
▪ Implementation of standard Enterprise Resource Planning (ERP) solution ▪ Readiness for the conversion of national currencies to the Euro ▪ Implementation of new logistics capabilities ▪ ERP upgrade project ▪ Product delivery/installation project (network infrastructure) ▪ Implementation of new Product Data Management (PDM) solution ▪ Implementation of new Demand Planning solution ▪ Improvements to existing products	▪ Development of entirely new supply chain capabilities (including business process and IT solutions) ▪ Specification of a new business-to-business data interchange standard ▪ New product development ▪ Cost saving project (for existing product) ▪ Specification of a new mode of operations and organizational structure ▪ Development of new in-house supplier collaboration solution

The first category of projects relied on exploiting existing competences. Typical for this category of projects was that the problem to be solved was well formulated, and the means to do so could be planned. The need for exploration was low. Examples include projects that focused on the implementation of standard IT solutions. While it could be argued that the organization needed to learn new skills for the effective use of these solutions, the projects were not tasked with defining these skills. Instead, the solution was to be implemented in accordance with instructions from the vendor. Projects where a high degree of exploration was needed became the second category. This category contained projects that specifically focused on developing new solutions and competences.

4.3 Formality, discretion, and exploration

As with formality, also project discretion was sometimes described with negative connotations. Many had a firm belief in structure and formal methodology as means of ensuring project success, and many examples of the positive effects of a strict methodology were presented. On the opposite side, the interviews also revealed cases where formality was misplaced, and discretion was called for. In this section, specific projects are examined in more detail to establish the relationship between formality, discretion, and exploration. Figure 2 illustrates a categorization of projects along these dimensions, summarizing which projects relied on a high degree of formality (example projects III, IV and V), and the projects that exhibited high discretion (projects I, II, VI, and VII). Further, Figure 2 details whether these projects were characterized as exploratory or not. These projects are a subset of all the projects included in the QCA (see Appendix B).

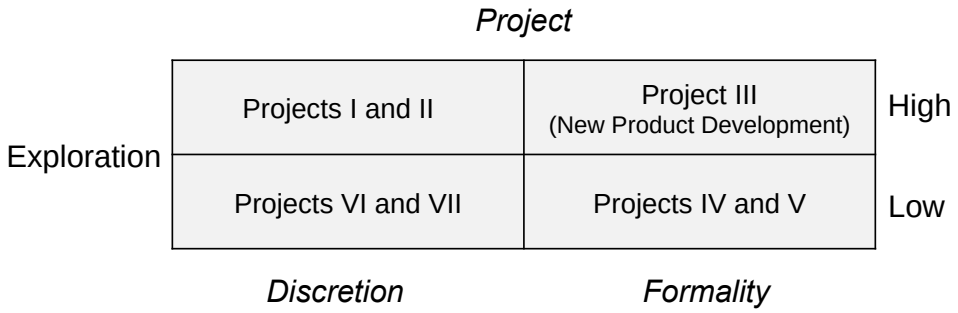

Figure 2. Project categorization based on work practices and degree of exploration

One informant described a large-scale project (project I) that involved more than one hundred suppliers, several international logistics service providers, development of new business processes, as well as new IT solutions. Project I spanned over several years and as a result, highly innovative, new supply chain capabilities were developed. While there were major challenges along the way, the informant considered the project very successful. The way of working in the project was characterized by discretion.

> *I just remember that I wrote a concept description, since I thought a concept description is needed. […] Then we concluded that a RosettaNet specification [XML based standard for electronic communication] is still missing. So, I went ahead and developed that. And then we started implementing all of this. […] If I remember correctly, this was implemented mostly through personal contacts in IT. I convinced a person I know in IT that this is needed. Maybe there then was some sort of steering group that gave the final approval, but basically, we got this done through entirely other means. (Interview #3)*

The next project (project II) concerned the development of a new database product. Conducted more than 30 years ago, the project developed a product that is still maintained and sold today. Discretion again played a big role in the project, and the informant indicated that this could have played a big role in the innovative nature of project II, both in terms of ways of working and outcome. The informant described the circumstances behind the success of the project as follows:

> *An open-minded attitude. We didn't have any practical experience with this kind of real-time systems. We basically went into it blind. […] At the time, we didn't know anything about project management either, so there were no inhibitions. […] We were also highly innovative because we also developed our own database query language. (Interview #11)*

Projects I and II are positioned as projects that exhibit exploration, while work practices are characterized by a high degree of discretion.

The interviews also included examples of formality coupled with a need for exploration. Nokia experienced a high degree of competition from both low-cost manufacturers and other new competitors. The product development process for mobile phones (project III) essentially followed the internal TPM methodology, and several informants revealed a certain degree of frustration with the somewhat rigid fashion in which new products were introduced. While some acknowledged that there are clear reasons (e.g., quality-related) to pursue a very structured approach to product development, a more localized approach could be put in place to counter smaller competitors with innovative products. Also, truly "new and groundbreaking" products could have benefitted from a less rigid approach.

> *We have enough people, we have enough expertise, but we don't have enough of a practical approach. […] We should be faster than them. (Interview #7)*

In this description, the lack of a "practical approach" is impeding the ability to counter small but fast competitors, who are very reactive to changing market conditions. As such, new product development projects are categorized as reliant on formality, while at the same time requiring a high degree of exploration during the project.

Project IV was a large-scale project concerned with the implementation of a new enterprise resource planning (ERP) solution for one division of the company. This project employed a milestone-based project methodology that later evolved into the companywide, formal methodology used across projects. The ERP solution was a standard, off-the shelf software package. A large part of the implementation involved the harmonization of business process across 44 different countries. In this sense, the formal methodology was used to sanction conformity rather than any form of exploration.

> *The challenge was specifically that every creek and island had their own managers, processes, ways of working, and system. There was a hell of a lot of complaints when we said, listen up, now each and every one should take [name of the ERP system] customer order management into use. […] So, we ended up using a clear-cut template [for the implementation], for example, with milestones with clear criteria [for completion]. The primary use was to get rid of these endless discussions, that 'this is no good for us.' […] The change management involved in getting global processes in place in a timely manner simply requires a clear project template. (Interview #2)*

One informant had been involved in an IS project concerning the readiness for the Euro currency (project *V*). This involved changes to accounting systems, but also a thorough review of existing contracts that were in soon to-be legacy currencies. Project V involved a high degree of planning ahead, together with a formalized risk management process.

> *So, then it became a matter of executing and just gathering the data and fixing it. So instead of innovation, it's just problem solving. […] Let's communicate it well and let's keep monitoring and making sure that it's working. And then we have a fallback plan if that something fails. (Interview #16)*

In projects IV, and V, we saw formality coupled with a low degree of exploration.

Our next example (project VI) exhibits a high degree of management direction in terms of setting the schedule for the effort. The project in question concerned the implementation of the ERP solution in the second major division of the company. Formality and planning became difficult due to the aggressive schedule imposed by management.

> *It's completely chaotic, very poor this visibility to kind of what stage are we [in]? Which thing should we do first? By setting [a] very aggressive schedule they were basically really destroying the process there, not doing things in the right sequence. Trying to achieve something really, really fast and… That was a nightmare. (Interview #16)*

In project VII, the intention was to implement a demand management tool for a particular division. This tool had earlier been implemented elsewhere in the company. The earlier, successful implementation was described to us as a having a "process perspective" with "timetables, what is to be done, when, and how". However, the account presented to us of a later implementation in the other division was substantially different:

> *But then, when this was taken to [division 2 of the company] what happened was that they took the subjective opinions of different people and tried to implement all of them. In the end, it became an amoeba that no one controlled. (Interview #14)*

According to the descriptions portrayed to us, projects VI and VII lacked formality; we categorized these projects as having a high degree of discretion. These projects were implementing standard solutions already developed and implemented elsewhere. As such, the need for exploration was low. Project steering relying on discretion seemed misplaced, resulting in projects that were largely perceived as unsuccessful.

4.4 Summary of interview results

A framework that summarizes our coding of the interviews is presented in Figure 3. The circles represent the final coding categories. Each project was first categorized based on the role of exploration in the project; was the need for exploration high or low? After this, the informant's view on the success of the project was determined, and what type of practices had an impact on the perceived success. Formality coupled with a low degree of exploration in the project, sometimes implying a need for conformity, worked well. On the other hand, a high degree of discretion in these kinds of projects was typically depicted as leading to failure. On the opposite side, when a high degree of exploration is required, discretion was better suited to govern the project than formality.

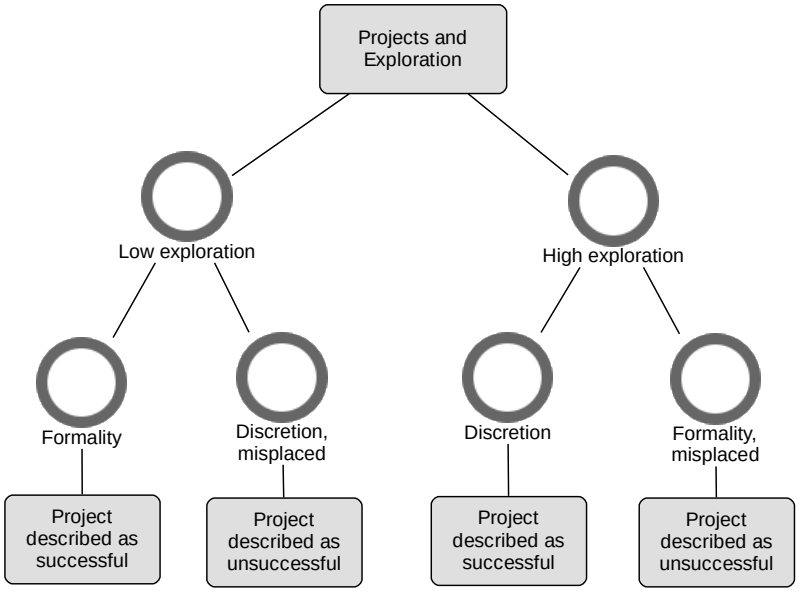

Figure 3. Interview coding categories

4.5 Validating and extending the model

The results of the QCA supported our findings from the interview analysis. The reduced equation for project success (O = abc + ACE + BCF + cd, see Appendix B) implies that successful projects with low exploration relied on TPM. Alternatively, projects with high exploration relied on either APM or full discretion to manage the project. In addition, a 'holistic architecture' was instrumental for agile projects, whereas projects with full discretion also demonstrated 'successful internal sales'. The last two conditions for successful projects, 'cd', imply that low exploration and low structural complexity lead to successful projects. This is likely to be the case. Yet, this "ideal" starting point for a project is far from the conditions many organizations and project managers face.

The need for a holistic architecture in structurally complex agile projects along with internal sales in projects with full discretion, prompted us to re-examine these projects in more detail. While agile projects 28 and 31 (see Appendix B) had challenges with managing interdependencies, similar projects such as numbers 12 and 35 had mechanisms in place to ensure that the overall architecture was managed. Quoting our informants, project 12 employed "architects", and project 35 stressed "collective code ownership" between teams to deliver customer value. In other words, there were specific roles and mechanisms in place to manage structural complexity. The lack of internal sales was exemplified by high exploration projects that had difficulties in anchoring developments with operations, such as project 10 (interview #9): "we should have discussed this more with marketing".

5. Discussion

We set out to understand the role project management plays in enabling project success. In effect, our findings support a contingency view of projects. However, unlike previous contingency studies, we posit that understanding the role of exploration is key to adapting project management to context. In practice, the role of exploration in a project determines the amount of discretion needed. We maintain that there is a case for high formality and TPM in projects that rely on exploitation, whereas exploration projects benefit from discretion, either through APM or by fully discarding established methodologies.

Earlier studies that advocate oscillation between project formality and discretion largely fail to address the specific conditions that require either formality or discretion [14],[40],[41]. In this regard, APM is interesting. It represents a "compromise" between formality and discretion, effectively implementing both at the same time. This is perhaps why it has garnered such interest in a wide variety of projects. Yet, APM is not a "one-size-fits-all" solution to project management, as evidenced by persistent high failure rates also in agile projects [7]. One reason for this might be that APM is applied where TPM or full discretion would be more suitable.

5.1 Project management that enables project success

Figure 4 summarizes the results of this study; our data analysis supports the model outlined in the beginning of the paper. If the project focus is on refinement of the existing, formality should be high. Exploitation is emphasized, and TPM is suitable to manage these projects. On the other side, a need for high exploration to facilitate new ideas and competences calls for discretion. In practice, pre-defined methodology is discarded in favor of an emergent project. Deviating from the outlined continuum in Figure 4 creates challenges, either due to incoordination or a "red tape". Incoordination implies at insufficient rules, processes, and structures for the project, whereas "red tape" is methodology inhibiting exploration through the same mechanisms.

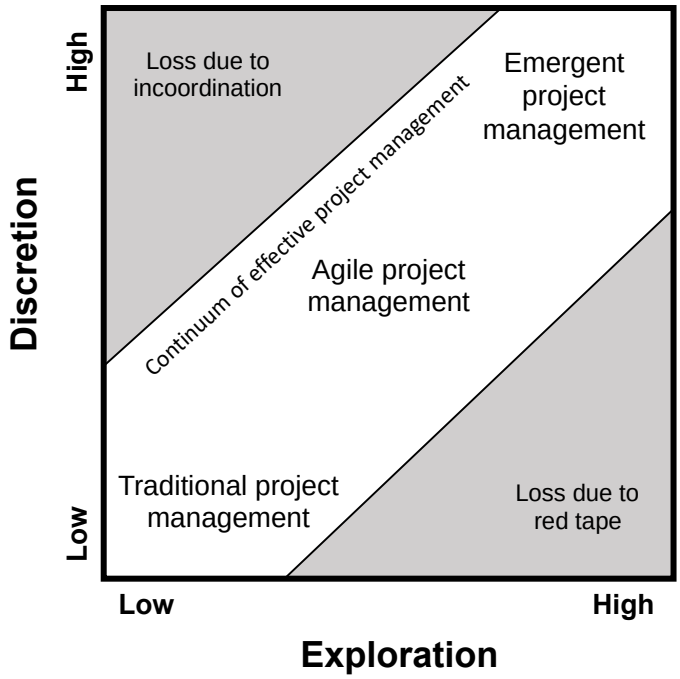

Figure 4. Relationship between discretion, project management, and exploration

Looking at this principle with the help of the project examples outlined in Section 4.3, we note that project one (I) belongs in the emergent project management category. This does not suggest an unsystematic way of working, but instead, high discretion and little or no adherence to a predefined methodology. On the other side of the spectrum, project four (IV) concerned the implementation of a standard ERP solution. The need for exploration was small as the focus was on implementing a standard IT solution. The focus was on uniform ways of working, and no exception to this rule was deemed acceptable. Formality to regulate behavior was important, both in terms of the project activities, but also to manage change. TPM was used for effect.

The degree to which exploration was needed in projects one (I) and four (IV) was different, as was the approach to project management. In effect, the temporary organization was used to provisionally overturn organizational focus. In project IV, this effectively meant that methodology was used to ensure conformity, to a degree the antithesis of what a company in the high-tech sector needs. In contrast, project I used the temporary organization to ensure that established ways of working are discarded. This emergent project management methodology allowed for the development of entirely new competences and solutions.

Project management methodologies always contain a degree of formality, but APM allows for a degree of discretion that can support exploratory initiatives. At the same time, a complete departure from established methodologies might be needed under certain conditions. Several scholars have noted that high exploration requires a move away from an instrumental view of a project [43]-[45]. Our study shows that this can mean that project methodologies should be discarded altogether. Despite the prevalence of APM, we also note that TPM can be very effective when the need for exploration is low. The implementation of standard software might be such a case. These IS projects might in fact benefit from low discretion, emphasizing the word ‘standard’ also in terms of how the project is managed.

5.2 Other factors affecting project success

Based on the QCA, we note that agile projects require attention to handle the effects of high structural complexity, specifically challenges with project interdependencies and architecture. Similar findings have been reported in other studies [35]-[37]. Unlike previous studies, we do not see structural complexity as a determining factor for selecting a project methodology [12],[16],[20],[32],[34], but emphasize the need to address structural complexity in agile projects. In practice, structurally complex agile projects might require mechanisms or project roles that ensure a holistic approach.

Further, the data revealed that successful emergent projects need to pay attention to internal sales. As these projects developed entirely new solutions, it is reasonable to assume that acceptance by the operative organization is not given. As such, emergent projects can benefit from practices inherent to APM, specifically emphasizing customer involvement throughout the project [35]. This ensures that customer requirements are considered.

6. Conclusion

6.1 Implications for theory

Scholars recognize the challenge with adapting projects to their actuality [9]-[13]. Complementing previous studies, we posit that the role of exploration is a key consideration when determining how projects should be managed; this should drive the degree of discretion applied in the project. We stress the need to not only distinguish between low and high exploration projects, but also provide directions for the management of said project types. In practice, high exploration projects require a high degree of discretion, whereas low exploration projects benefit from formality. Unlike previous studies that suggest development projects benefit from both formality and discretion [14],[40],[41], we separate the specific project types that benefit from either formality or discretion. In this vein, we also note that high discretion might mean that project methodologies are discarded altogether. This can create the necessary conditions for developing entirely new solutions. APM is effectively a compromise between formality and discretion, yet no silver bullet. For example, applying APM when implementing standard software can be challenging; APM allows for iteration, feedback,

and new paths that might in fact be undesirable in these projects. In these instances, TPM can be a better choice for managing the project.

6.2 Implications for practice

Projects can be used to both foster innovation and sanction conformity. Echoing previous research, this requires a move away from a uniform view of projects and how work therein is controlled [10],[11],[13]. Methodologies are used to legitimize formality – *sometimes* to their benefit. However, this paper puts forward that a uniform application of methodologies, be it traditional waterfall or agile, is the antithesis of what a successful project environment calls for. Further, the organization needs to consider whether to apply a methodology at all or whether to simply disregard predefined practices for project success. In effect, the temporary nature of the project needs to be used to its full potential. This means that structures prevalent in the organization can be provisionally overturned to either promote exploration and innovation, or sanction conformity and emphasize exploitation. These temporary structures need to be reconsidered for every project.

6.3 Limitations and future research

The focus of this study was on IS and product development projects. There are limitations in terms of the applicability of our findings to other project types. Further, this study looks at project work in one large high-tech company and its supplier. It is likely that the findings are applicable in this context; start-ups and smaller companies probably operate with far less bureaucracy and control. Similarly, public organizations might have time and budgetary limits that impact the choice of project management. At the same time, the projects examined in this study represent a diverse set of projects. As such, we believe the findings are useful in many large organizations having a wide variety of development needs.

Project management competence was not considered a variable in our analysis. All informants had a long background in managing projects, and some in managing teams of project managers. Organizations are likely to appoint people with experience in projects to manage temporary organizations, assuming experienced project managers are available. These experienced project managers are likely to be found in larger organizations, further stressing the applicability of our findings in this setting.

The limitations described above would merit further testing of the framework outlined in this paper in different contexts, including smaller companies, different industries, as well as public organizations. Given the prevalence of APM, we would also encourage studies that look at how suitable APM is in large-scale implementations of standard software, specifically in comparison with traditional methods with a higher degree of formality. The notion of disregarding methodology altogether is also a topic that would warrant further investigation, providing further descriptions of what a contingent approach to project management could look like in practice.

References

[1] G. Fernandes, S. Ward and M. Araújo, "Identifying useful project management practices: A mixed methodology approach," *International Journal of Information Systems and Project Management*, vol. 1, no. 4, pp. 5-21, 2013.

[2] K.E. Papke-Shields, C. Beise and J. Quan, "Do project managers practice what they preach, and does it matter to project success?" *International Journal of Project Management*, vol. 28, no. 7, pp. 650-662, 2010.

[3] P. Serrador and J.K. Pinto, "Does Agile work? - A quantitative analysis of agile project success," *International Journal of Project Management*, vol. 33, no. 5, pp. 1040-1051, 2015.

[4] PMI, *A guide to the project management body of knowledge (PMBOK guide)*, 7th ed. Newtown Square, USA: Project Management Institute, 2021.

[5] D. Milosevic and P. Patanakul, "Standardized project management may increase development projects success," *International Journal of Project Management*, vol. 23, no. 3, pp. 181-192, 2005.

[6] TSO, *Managing successful projects with PRINCE2*, Norwich, UK: The Stationary Office, 2017.

[7] S. Hastie and S. Wojewoda. (2022, May 15). *Standish Group 2015 Chaos Report - Q&A with Jennifer Lynch* [Online]. Available: https://www.infoq.com/articles/standish-chaos-2015/

[8] M. Pace, "A correlational study on project management methodology and project success," *Journal of Engineering, Project & Production Management*, vol. 9, no. 2, pp. 56-65, 2019.

[9] B. Hanisch and A. Wald, "A bibliometric view on the use of contingency theory in project management research," *Project Management Journal*, vol. 43, no. 3, pp. 4-23, 2012.

[10] A.J. Shenhar, "One size does not fit all projects: exploring classical contingency domains," *Management Science*, vol. 47, no. 3, pp. 394-414, 2001.

[11] B.J. Sauser, R.R. Reilly and A.J. Shenhar, "Why projects fail? How contingency theory can provide new insights - A comparative analysis of NASA's Mars Climate Orbiter loss," *International Journal of Project Management*, vol. 27, no. 7, pp. 665-679, 2009.

[12] A.J. Shenhar and D. Dvir, *Reinventing project management: the diamond approach to successful growth and innovation*, Boston, USA: Harvard Business Review Press, 2007.

[13] R. Joslin and R. Müller, "The impact of project methodologies on project success in different project environments," *International Journal of Managing Projects in Business*, vol. 9, no. 2, pp. 364-388, 2016.

[14] E. Naveh, "Formality and discretion in successful R&D projects," *Journal of Operations Management*, vol. 25, no. 1, pp. 110-125, 2007.

[15] R.K. Wysocki, *Effective project management: traditional, agile, extreme*, Indianapolis, USA: Wiley, 2009.

[16] C.W. Butler, L.R. Vijayasarathy and N. Roberts, "Managing software development projects for success: Aligning plan- and agility-based approaches to project complexity and project dynamism," *Project Management Journal*, vol. 51, no. 3, pp. 262-277, 2020.

[17] J.G. March, "Exploration and exploitation in organizational learning," *Organization Science*, vol. 2, no. 1, pp. 71-87, 1991.

[18] D.A. Levinthal and J.G. March, "The myopia of learning," *Strategic Management Journal*, vol. 14, pp. 95-112, 1993.

[19] J. Iivari, "A framework for paradoxical tensions of project management," *International Journal of Information Systems and Project Management*, vol. 9, no. 1, pp. 5-35, 2021

[20] T. Williams, "Assessing and moving on from the dominant project management discourse in the light of project overruns," *IEEE Transactions on Engineering Management*, vol. 52, no. 4, pp. 497-508, 2005.

[21] R. Müller and K. Jugdev, "Critical success factors in projects: Pinto, Slevin, and Prescott - the elucidation of project success," *International Journal of Managing Projects in Business*, vol. 5, no. 4, pp. 757-775, 2012.

[22] P. Serrador and R. Turner, "The relationship between project success and project efficiency," *Project Management Journal*, vol. 46, no. 1, pp. 30-39, 2015.

[23] L. Siddique and B. A. Hussein, "A qualitative study of success criteria in Norwegian agile software projects from suppliers' perspective," *International Journal of Information Systems and Project Management*, vol. 4, no. 2, pp. 63-79, 2016

[24] L. Koskela and G. Howell, "The theory of project management: explanation to novel methods," in *Proceedings of IGLC-10, 10th Conference of Int. Group for Lean Construction*, Gramado, Brazil, 2002, pp. 1-11.

[25] R.B. Johnston and M. Brennan, "Planning or organizing: the implications of theories of activity for management of operations," *Omega*, vol. 24, no. 4, pp. 367-384, 1996.

[26] K. Beck, M. Beedle, A. van Bennekum, M. Fowler and J. Highsmith (2022, May 15), *Manifesto for Agile Software Development* [Online]. Available: https://agilemanifesto.org

[27] D.J. Fernandez and J.D. Fernandez, "Agile project management - agilism versus traditional approaches," *Journal of Computer Information Systems*, vol. 49, no. 2, pp. 10-17, 2008.

[28] M. Laanti, O. Salo and P. Abrahamsson, "Agile methods rapidly replacing traditional methods at Nokia: A survey of opinions on agile transformation," *Information and Software Technology*, vol. 53, no. 3, pp. 276-290, 2011.

[29] S. Lenfle and C. Loch, "Lost roots: How project management came to emphasize control over flexibility and novelty," *California Management Review*, vol. 53, no. 1, pp. 32-55, 2010.

[30] A. De Meyer, C.H. Loch and M.T. Pich, "Managing project uncertainty: from variation to chaos," *MIT Sloan Management Review*, vol. 43, no. 2, pp. 60-67, 2002.

[31] S. Collyer, C. Warren, B. Hemsley and C. Stevens, "Aim, fire, aim - Project planning styles in dynamic environments," *Project Management Journal*, vol. 41, no. 4, pp. 108-121, 2010.

[32] J. Geraldi, H. Maylor and T. Williams, "Now, let's make it really complex (complicated): A systematic review of the complexities of projects," *International Journal of Operations & Production Management*, vol. 31, no. 9, pp. 966-990, 2011.

[33] S. Morcov, L. Pintelon and R. Kusters, "Definitions, characteristics and measures of IT project complexity - a systematic literature review," *International Journal of Information Systems and Project Management*, vol. 8, no. 2, pp. 5-21, 2020

[34] T.M. Williams, "The need for new paradigms for complex projects," *International Journal of Project Management*, vol. 17, no. 5, pp. 269-273, 1999.

[35] K. Petersen and C. Wohlin, "A comparison of issues and advantages in agile and incremental development between state of the art and an industrial case," *Journal of Systems and Software*, vol. 82, no. 9, pp. 1479-1490, 2009.

[36] T. Dybå and T. Dingsøyr, "Empirical studies of agile software development: A systematic review," *Information and Software Technology*, vol. 50, no. 9-10, pp. 833-859, 2008.

[37] M. Paasivaara, B. Behm, C. Lassenius and M. Hallikainen, "Large-scale agile transformation at Ericsson: a case study," *Empirical Software Engineering*, vol. 23, no. 5, pp. 2550-2596, 2018.

[38] R. H. Lobsitz, "A method for assembling a project-specific software process definition," *Proceedings of HICSS-29: 29th Hawaii International Conference on System Sciences*, Wailea, HI, USA, 1996, pp. 722-730

[39] N. Turner, E. Kutsch and S.A. Leybourne, "Rethinking project reliability using the ambidexterity and mindfulness perspectives," *International Journal of Managing Projects in Business*, vol. 9, no. 4, pp. 845-864, 2016.

[40] M.V. Tatikonda and S.R. Rosenthal, "Successful execution of product development projects: Balancing firmness and flexibility in the innovation process," *Journal of Operations Management*, vol. 18, no. 4, pp. 401-425, 2000.

[41] M.W. Lewis, M.A. Welsh, G.E. Dehler and S.G. Green, "Product development tensions: Exploring contrasting styles of project management," *Academy of Management Journal*, vol. 45, no. 3, pp. 546-564, 2002.

[42] R.M. Henderson and K.B. Clark, "Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms," *Administrative Science Quarterly*, vol. 35, no. 1, pp. 9-30, 1990.

[43] S. Lenfle, "Exploration and project management," *International Journal of Project Management*, vol. 26, no. 5, pp. 469-478, 2008.

[44] R.G. McGrath, "Exploratory learning, innovative capacity, and managerial oversight," *Academy of Management Journal*, vol. 44, no. 1, pp. 118-131, 2001.

[45] A.J. Shenhar, V. Holzmann, B. Melamed and Y. Zhao, "The challenge of innovation in highly complex projects: What can we learn from Boeing's Dreamliner experience?" *Project Management Journal*, vol. 47, no. 2, pp. 62-78, 2016.

[46] B.G. Glaser and A.L. Strauss, *The Discovery of Grounded Theory: Strategies for Qualitative Research*, Hawthorne, USA: Aldine, 1967.

[47] C.C. Ragin, *The comparative method: Moving beyond qualitative and quantitative strategies*, Oakland, USA: University of California Press, 2014.

[48] C.C. Ragin and L.M. Amoroso, *Constructing social research: The unity and diversity of method*, Thousand Oaks, USA: Pine Forge Press, 2011.

[49] P. Alasuutari, *Laadullinen tutkimus*, Tampere, Finland: Vastapaino, 1994.

[50] L. Cronqvist. (2022, May 15). *QCA Add-In, University of Trier (Version 1.1)* [Online]. Available: https://www.qca-addin.net

[51] P.C. Fiss, "Building better causal theories: A fuzzy set approach to typologies in organization research," *Academy of Management Journal*, vol. 54, no. 2, pp. 393-420, 2011.

[52] C.C. Ragin, D. Shulman, A. Weinberg and B. Gran, "Complexity, generality, and qualitative comparative analysis," *Field Methods*, vol. 15, no. 4, pp. 323-340, 2003.

Appendix A. The Interviews

#	Time	Title	Project type*	Language**
1	07/2011	Director	Product development	Finnish
2	08/2011	Director		Finnish
3	09/2011	Head of	Information systems	Finnish
4	09/2011	Vice President	Product development	Finnish
5	09/2011	Senior Manager	Information systems	Finnish
6	09/2011	Director	Information systems	Finnish
7	09/2011	Senior Specialist	Product development	English
8	09/2011	Director	Information systems	Finnish
9	09/2011	Senior Manager	Product development	Swedish
10	11/2011	Senior Manager	Information systems	Finnish
11	11/2011	Head of	Product development	Finnish
12	11/2011	Manager	Information systems	Finnish
13	01/2012	Senior Manager	Information systems	Finnish

#	Time	Title	Project type*	Language**
14	01/2012	Director	Information systems	Finnish
15	02/2012	Senior Manager	Information systems	Finnish
16	02/2012	Manager	Information systems	English
17	03/2012	Senior Manager	Information systems	Finnish
18	03/2012	Vice President	Information systems	English
19	03/2012	Manager	Information systems	Finnish
20	04/2012	Vice President	Product development	Finnish
21	04/2012	Vice President	Information systems	Finnish
22	04/2012	Director	Information systems	Finnish
23	10/2012	Manager	Product development	Finnish
24	10/2012	Manager	Product development	Finnish
25	10/2012	Manager	Product development	Finnish
26	11/2012	Head of	Product development	Finnish
27	11/2012	Head of	Product development	English
28	11/2012	Head of	Product development	English
29	11/2012	Head of	Product development	English
30	11/2012	Head of	Product development	English
31	01/2013	Senior Engineer	Product development	English
32	01/2013	Manager	Product development	English

* Project type refers to what kind of projects were primarily discussed during the interview.

** When applicable, translation to English has been done by the authors.

Appendix B. QCA Truth table and prime implicant chart

B.1. Truth table

	Causal Conditions						*Project success (O)*	
Projects (case # in QCA/ project number in interview analysis)	APM (A)	Full discretion (B)	High exploration (C)	High structural complexity (D)	Holistic architecture (E)	Successful internal sales (F)	Yes	No
4, 16, 23/V	0	0	0	0	1	1	3	0
1/IV, 13, 17, 22, 24	0	0	0	1	1	1	5	0
18	0	0	0	1	1	1	1	0
14	0	0	1	0	1	0	0	1
6/III	0	0	1	0	1	1	0	1
19	0	0	1	1	1	0	0	1
2	0	0	1	1	1	1	0	1
5	0	1	0	0	1	1	1	0
21/VI	0	1	0	1	1	1	0	1
25, 26, 27	0	1	1	0	1	1	3	0
11/II	0	1	1	1	1	1	1	0
10	0	1	1	1	1	0	0	1
3/I	0	1	1	1	1	1	1	0
15	1	0	0	0	1	1	1	0
20/VII	1	0	0	1	1	1	0	1
30	1	0	0	1	1	1	0	1
29, 32	1	0	1	0	1	1	2	0
28, 31	1	0	1	1	0	1	0	2
12, 35	1	0	1	1	1	1	2	0
7, 8, 9, 33, 34 (excluded)								
All other combinations of conditions (45)							?	?

NOTE: 1 = yes, 0 = no. Variable names in parentheses are the mnemonics used in Boolean equations.

B.2. Prime implicant chart for outcome (project success)

Terms to cover (O = 1, project successful)									
		Primitive expressions							
		abcdEF	*abcDEF*	*AbCdEF*	*AbCDEF*	*AbcdEF*	*aBCdEF*	*aBCDEF*	*aBcdEF*
Prime implicants	abc	x	x						
	ACE			x	x				
	Ad			x		x			
	BCF						x	x	
	Bd						x		x
	cd	x				x			x

Reduced equation: O = abc + ACE + BCF + cd

Biographical notes

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Abstract:
Restrictive Scrum assumptions make the effectiveness of this approach debatable in projects deviating from typical execution conditions. This article delivers a comprehensive software development approach for both academic and commercial Information Technology (IT) projects effectuated by teams that are hampered by significantly unsystematic participation of project members and mercurial internal communication. The nature of 'ad-hoc' projects imposes another level of difficulty in terms of both managing the conduct of such a project and ensuring the quality of the end product. Multicyclic action research enabled a gradual adaptation of the Scrum approach to support such project conditions. This study introduces major alterations to Sprint implementation and minor enhancements within the documentation process to streamline knowledge sharing among Development Team members. Proposed key alterations include the evolution of Daily Scrum towards Weekly Scrum, the possibility of extending Sprints length, the eventuality to switch team members during Sprint due to substantial failure to meet deadlines, having at least two team members responsible for a single Product Backlog Item (PBI) at all times, as well as exclusion of Burndown Chart in favor of Development Team members updating their working time. Positive validation of enhancements in mixed settings confirms that the generic Scrum framework can be adapted to support highly volatile projects. The proposed approach is suitable not only for carrying out software development initiatives that rely heavily on the skills of external experts and/or volunteers. It also supports traditional Scrum teams that seek to reduce their exposure to risk arising from organizational changes.

Keywords:
project management; agile; software development; systems engineering; Scrum; adaptation.

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1. Introduction

Challenges that most modern business entities face when launching Information Technology (IT) projects, put pressure on both global development teams and management staff to adapt novel techniques, approaches, and tools [1] – and thus decrease failure rates. Leveraging the strengths of various existing processes more effectively owing to the adaptability of Agile Methods (AMs) contributed to establishing the dominance of the latter [2]. That said, the leading agile approach to project management, i.e. Scrum, necessitates a fairly restrictive and precise application of underlying principles throughout the development process [3] – which often cannot be facilitated by companies [4]. Daily meetings at a specific time and duration, minimum and maximum constraints on the duration of individual Sprints, presence at meetings required from all team members as well as significant experience in implementing projects using this framework required from local programming teams, in fact, constitute the underlying problem behind the non-negligible share of IT projects. Moreover, being obliged to deliver demonstrable results in a short timeframe, regardless of their scope, tricks teams into ignoring software quality and creates a pileup of quality-related challenges. These challenges make Scrum – should it be used by the book – unsuitable for running projects in unfavorable conditions, such as highly irregular cooperation between development team members. The Scrum guide itself neglects to discuss how this approach might be adapted [5].

Therefore, our motivation was to retain Scrum's ability to deliver the final product on time and budget under the required functionality while enabling projects to be carried out effectively considering the significantly unsystematic project members' participation as well as mercurial internal communication and deliverables provision. Efficiency of project realization is especially important for individuals with more years of experience, as they have a higher perception of the importance of metrics related to Scrum team performance [6]. We reckon that the Scrum framework can be adapted to the successful execution of a wide range of IT projects falling into the 'ad-hoc' category. The irregular way of cooperation basically comprises collaboration based on infrequent (or even rare) meetings of Development Team members, with the possibility of considerable gaps between them. Such a manner of collaboration is typical for projects that we henceforth address as 'ad-hoc' ones. Our early conceptual work explored and highlighted the determinants of such projects, including:

- no systematic daily implementation [7];
- the Development Team structure varying significantly not only between the initiation points of individual Sprints, but also during their execution [8];
- a bulk of the Development Team members devoting only a small share of their professional work to contribute to the project or participating in the project as a side contract, resulting in divergent availability of members [9];
- strongly diversified levels of time commitment to the project between different developers [10];
- high volatility in the availability of certain members of the team [11],[12];
- virtual form of the Development Team due to the significant geographical dispersion of its members [13],[10];
- collaboration between Development Team members likely to take an irregular form [14],[15].

'Ad-hoc' projects are, ipso facto, not in line with a number of aforementioned agile assumptions. We define 'Ad-hoc' projects as ones realized by distributed teams with highly fluctuating structures. We identified no approach that adapts the generic Scrum framework's Sprints to provide for such projects in the subject-related literature. The preliminary analysis of related research was re-checked based on the full contents of the AIS eLibrary, ACM Digital Library, IEEE Xplore, Springer, Web of Science, Scopus, Science Direct, as well as the EBSCOhost multi-source, full-text repository. In total, 92 journals and 221 conference proceedings articles that are directly or indirectly related to the keywords such as Scrum, agile project management, software development method, systems engineering method, software development methodology, systems engineering methodology; combined with adoption, adapt, adaptation, limitations, customize, elaboration were explored.

Building upon our early concepts for overcoming the limitations of the generic Scrum framework to support 'ad-hoc' IT projects, the goal of this manuscript is to deliver a comprehensive, practically applicable, and meticulously validated solution for projects with such specificity. In doing so, we strive to find an answer to the following research question –

Can Scrum as the key representative of agile software development approaches be adapted to the successful execution of 'ad-hoc' IT projects? The importance of both the research aim and the question is supported by the findings of the study by Almeida and Carneiro [6], who highlighted that there is a great need for extending the knowledge about Scrum project management processes and their teams – in addition to offering important insights into the implementation of metrics for software engineering companies that adopt it.

The target solution must not be confined to academia but take into account the specifics of commercial IT projects as well. Thus, the proposed streamlined approach was field-tested throughout the development of IT solutions during projects that featured significantly non-systematic Development Team collaboration in both environments.

After the introduction, related studies are discussed. The research design employed to elaborate an agile project management approach along with an in-depth discussion on individual cycles is presented next. Subsequently, the results of the study are introduced, followed by a discussion.

2. Related research

IT projects face rapidly changing environments. This applies to both business and technological perspectives, where the determinants of technology acceptance often depend on the area and organizational context of its application [16]. The evolution of cooperation among project members led to the establishment of virtual teams, in which geographically distributed, and often culturally diverse individuals use sophisticated technologies for interaction and collaboration; raising organizational maturity transformed those teams from an innovative source of competitive advantage into an important and necessary part of any organization strategy [14].

Such fluctuations particularly hinder project planning and further implementation of requirements [17]. AMs are better adapted to projects with high uncertainty and risk, where significant changes in systems requirements are necessary [18]. Agile frameworks and methods focus on close cooperation between team members, delivery of demonstrable products being components of a system under development in relatively tight cycles, and limiting documentation processes to a necessary minimum [19]. Moreover, prioritizing responding to change swiftly over following a plan allows for more flexible execution of software development initiatives and a reduction in the number of fatal shortcomings [20]. Successful attempts were made to ensure synergies between the IT-enabled agile approach and business process management, thus making business processes highly adaptable rather than rigid [21].

Scrum, leveraged by as many as 87% of enterprises that take advantage of Agile techniques (which constitutes a rise from 58% over three years) – remains a safe leader as far as AMs are concerned [22]. As with any approach, the Scrum framework has several assumptions and artifacts explained in detail in its guide [23]. Many of them were tagged as inexpedient to be modified. Plenty of studies indicate that this is impractical in business practice [24],[4],[25], and the adaptation of the agile approach to the specifics of a given project is a must [5],[18],[10]. These assumptions mean that the Scrum approach that strictly adheres to the indicated principles may be of little use in projects with participants who do not cooperate on a regular basis and communication is exercised downright 'ad-hoc' within a virtual team.

To meet the challenge of dissonance between the rigidity of certain Scrum features and IT practice, profiling the approach to different organizational contexts might be considered a viable option [26]. When considering such an enhancement, it is crucial to avoid the 'Scrum but' trap; numerous organizations declare adherence to Scrum, yet tend to skip Scrum features that are uncomfortable for them and are directly related to internal issues of those organizations at the same time [27]. Scrum adaptations tend to be introduced primarily across three organizational settings: (1) vertical scaling – individual projects of embedding Scrum in larger organizational aspects, such as strategic planning [11],[12]; (2) size scaling – implementation targeted at small, medium, and large software development initiatives [9],[11]; and (3) distributed structure – overall cooperation between distributed teams [15]. This study falls into the last of those areas. Simultaneously, it extends this organizational setting with 'ad-hoc' project specificity that necessitates surrounding organizational context, such as team structure, to be highly agile. An abrupt increase in such sets of constraints on the operations of companies was noted in Europe during the COVID-19 pandemic.

All tailor-fittings ought to be carefully measured and supported by empirical data. In this regard, Stålhane et al. [28] assessed how to adapt Scrum for safety-critical projects, so that it can be used without losing the benefits that one gets from both incorporating AMs and conformance with the IEC 61508 standard – which manifests itself e.g. in strict planning. Rolland et al. [29] attempt to overcome the challenges associated with using Scrum in large-scale projects. They come up with a customized approach that incorporates experiences from a 3.5-year project involving 120 participants. To improve the way of working – especially between teams and stakeholders – task forces were established across teams, champion roles were implemented, the practice of specifying in advance prior to Sprints was introduced, redistributing tasks within Sprints and improvising mini-demos in the middle of Sprints were pioneered. Caballero and Calvo-Manzano [30], on the other hand, discuss the lesson learned while tailoring Scrum to the needs of a very small company. To achieve more efficient resource management, a high-level functional specification was introduced through requirement elicitation. Sprint design usually lasting less than three days was treated as a systematic activity aimed at improving the knowledge of the project before starting coding, and a Sprint test was carried out by the quality team.

Despite failing to identify contributions discussing adapting the Scrum framework's Sprints to solve the problem of irregular cooperation between the members of the Development Team, the literature review enabled highlighting studies indirectly related to this contribution, pointing out:

- the existence of factors that interfere with Sprint execution, such as 'ad-hoc' requests during mid-Sprint and low inter-departmental communication, as they impede knowledge transfer between project members [31],[32];
- difficulties in maintaining traditional project meetings, along with a solution providing for using global virtual teams (GVTs) to enable a distributed team structure and project type [25];
- skipping or modifying some Scrum components for practical reasons, so that the overall approach is no longer in line with Scrum's guidelines, tends to be employed in organizational environments [18],[10];
- the necessity to elaborate hybrid methods to adjust to fluctuating requirements [33],[34].

Adapting the Scrum framework for 'ad-hoc' projects in line with the goal of this study is also justified by the belief that it is impossible to design one general theory of project management due to the vast differences between project types and contexts [35]. Additionally, cultural differences can affect how a project is run, especially from the perspective of team interaction [36],[37]. Moreover, an abrupt increase in high fluctuation of development team structure with the requirement to work remotely as distributed teams was noted across Europe during the 1st wave of the COVID-19 pandemic [38] and, to our best knowledge, similar settings during IT projects realization with Scrum framework were not explored in prior studies.

Importantly, the article aims to adapt Scrum only to the minimum extent required. The premise for it is the finding of Havstron and Karlson [39], pointing out that when adopting and using an SDM it is important to stay true to the philosophy of the method. Otherwise, software developers might execute activities that do not lead to the intended outcomes.

3. Research design

3.1 Method

Development of hybrid approaches from one side benefits from the strengths of each approach, and, at the same time allows to avoid their weaknesses [34]. On the other side, adopting and using a Software Development Method (SDM) without compliance with its philosophy might lead to unintended outcomes [39]. Therefore, to meet the goal of the article, the action research (AR) method was implemented. Software engineering is empirical knowledge, a synthesis of the experience of thousands of software development centers [40]. AR is a method of qualitative inquiry strongly oriented towards resolving practical problems of real-world organizations [41]. In contrast to waterfall-based methods, AR is capable of recognizing local perspectives [42] and is cyclic in nature. At least two complete AR cycles are required to fulfill the requirement of the process being iterative [43]. In our study, three strictly related research cycles were taken into account – with a 5-phase AR design employed within each cycle (Fig. 1). Decision to opt for five

phases was prompted by the team's previous involvement in research work based on such design, and thus knowledge of the subtleties of the method.

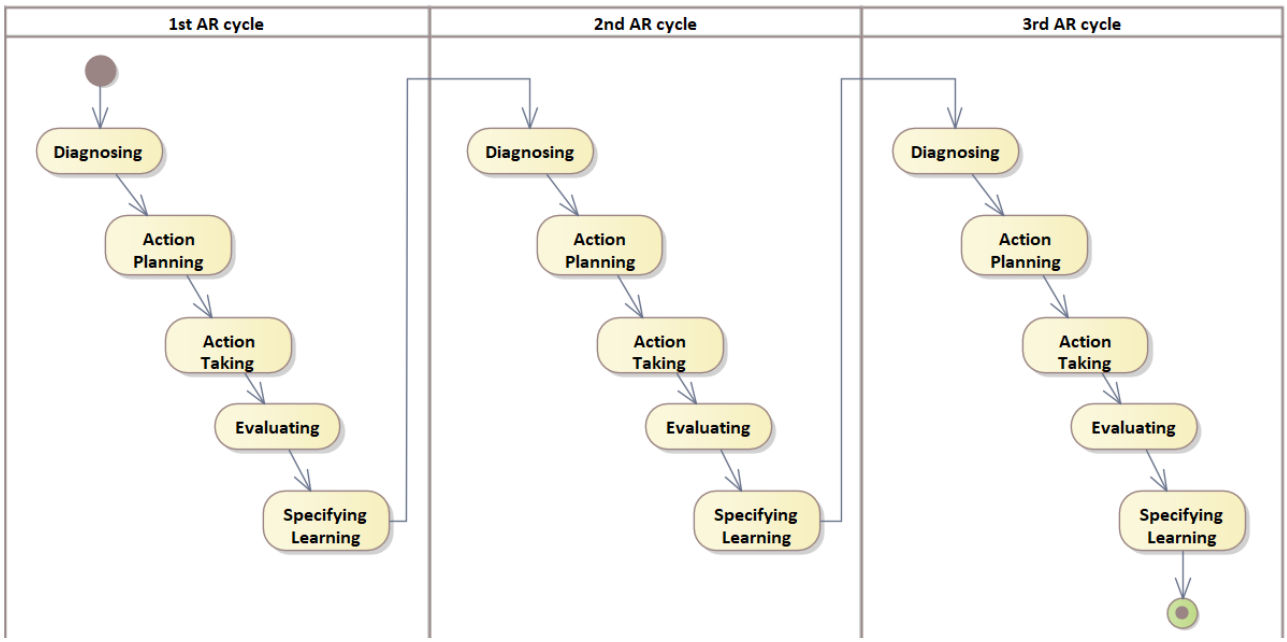

Fig. 1. High-level AR design underlying the study

Evaluation-oriented activities that ought to be considered while designing and running each cycle enable putting forward working hypotheses/propositions as well as assessing the legitimacy and direction of activities undertaken to drive organizational change and verify those propositions in a real organizational setting. At the same time, the unpredictability of real-world settings in which the change is implemented combined with the necessity to provide added value beyond an analysis of a given phenomenon calls for high flexibility of the method. The working nature of hypotheses and the ability to redirect research efforts between succeeding cycles deliver just that.

The study covered a couple of IT projects. One of the projects was executed within a student-exclusive environment, whereas the other was within a commercial one. Both scrutinized projects were effectuated in an agile way by virtual and geographically dispersed teams cooperating in a highly irregular manner, which contributed to a complex project implementation environment. The initial cycle was accomplished in a strictly academic setting, as persuading companies to allow conducting early stages of experimental research in the project management field during real-world software development projects often proves to be challenging. Deliverables of the study (Fig. 2) were subsequently drafted and tuned in within academic and commercial settings respectively (2nd and 3rd AR cycle) to ensure their universal nature. The decision to cover both non-commercial and commercial IT projects of different sizes was dictated by presumably dissimilar deviation levels from respective project plans due to Development Team structure changes resulting from no financial dependence of Development Team members. Moreover, we were vitally interested in determining whether these deviations are higher for volunteer-based projects, and whether individual adaptations may play a more important role than for commercial ones or not.

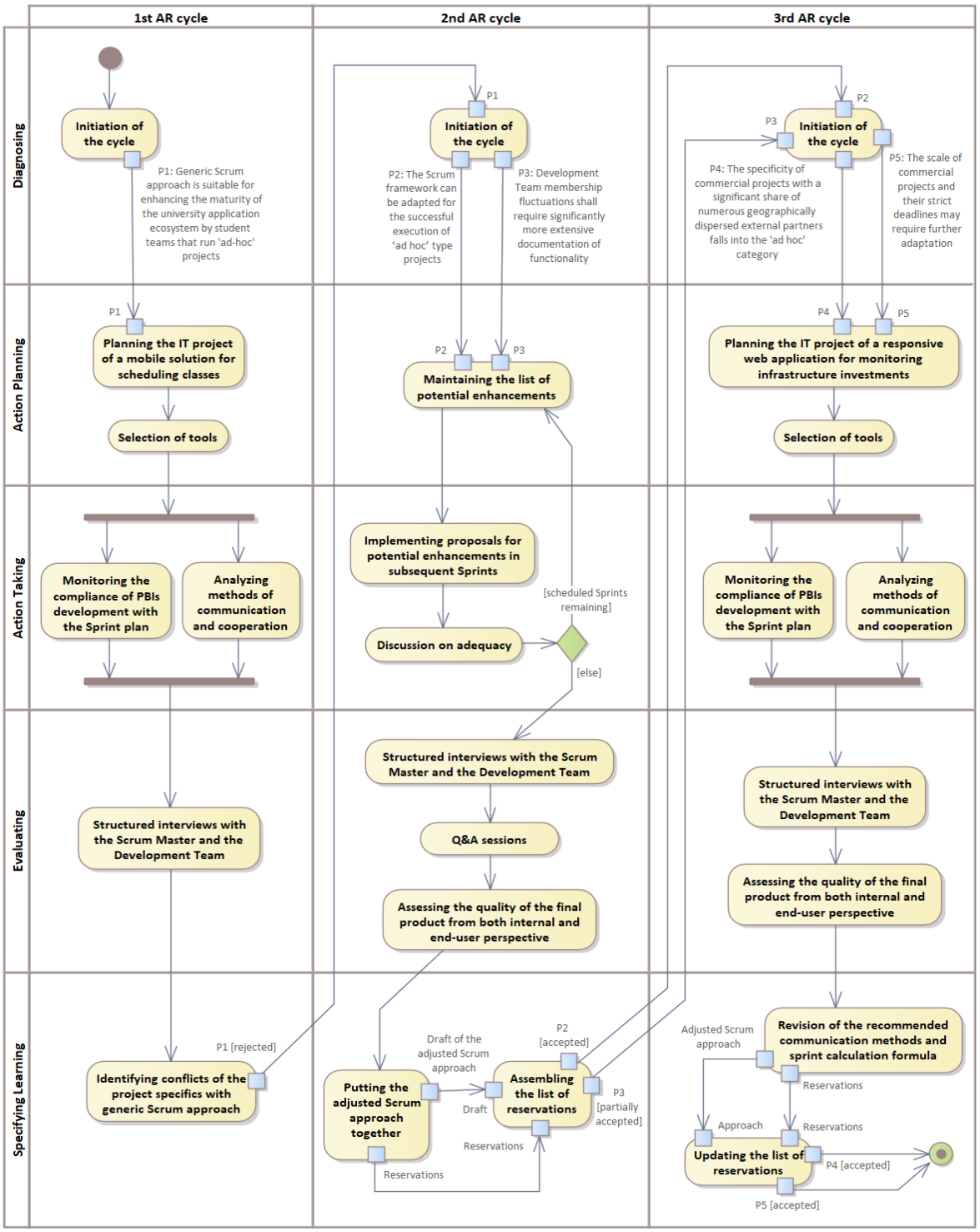

Fig. 2. Detailed AR design underlying the study

3.2 The first AR cycle

The groundwork for elaborating Scrum approach enhancements was laid in the early stages of a project executed by nine IT students: members of a student scientific society at the University of Gdansk, Poland. Five members of the Development Team combined university studies with the occupation of junior/regular developers. Their professional experience ranged from half a year to two years. In detail, the Development Team consisted of:

- mid developer – one student already working a part-time job for two years;
- junior plus – one student already working a part-time job for one year and a half;
- juniors – three students already working a part-time job for one year (two students) or half a year (one student);
- four outstanding students with no professional experience – two final year (third) students and one student in the second year.

The learning curve was of moderate length as the Development Team had complete freedom when choosing the technologies used. The frameworks adopted for system development were the ones already learned by students during their studies, and used for professional projects by mid, junior plus, and one junior developer.

The team planned and launched a project aimed at designing and building a mobile solution for both students and academic staff, which enables the management of class schedules. The specifics of the project pointed towards a good fit with generic AMs. First of all, only major requirements were known at the inception of the project, as the list of functionalities was closely related to the technical capabilities for importing relevant data from the main scheduling system that had evolved over time. Moreover, the mobile application was to be built following a flexible Web Oriented Architecture (WOA) to enable data exchange between different mobile platforms, as well as the web version of the solution. The risk of replacing some of the technologies used also had to be considered. Therefore, working research proposition P1 was put forward: *the generic Scrum approach is suitable for enhancing the maturity of the university application ecosystem by student teams that run 'ad-hoc' projects*.

Within the *Action Planning* phase, the team agreed upon the following primary functionality:

- collating data from relevant university websites: course plans, faculty staff's consultation hours, classroom availability, announcements, and information on important academic events;
- presentation of data obtained in a highly interactive way;
- multi-layer filtering of data related to class schedules, academic staff, and academic events;
- data processing through supplementing, removing, or modifying information on class schedules or consultation hours of academic staff;
- subscribing to events and receiving reminders via email;
- displaying alerts for upcoming events, such as exams.

Two Sprints have been covered by the first AR cycle. *Action Taking* phase soon revealed that project team members rarely had the opportunity to communicate with each other to transfer and share knowledge through face-to-face meetings. It was caused mainly by conflicts in students' class schedules where divergent days of the week and hours were available. Moreover, two out of nine students studied extramurally, combining working during weekdays with studying during weekends. As a rule, an online solution was used for (1) synchronous communication using TeamViewer video conferencing software; and (2) asynchronous communication based on Facebook groups and email. Project management was supported by Visual Studio Team Services (currently Azure DevOps), Trello, and Scrum templates prepared in Excel and shared via Google Drive. Since the *Evaluating* phase confirmed many issues, the list of conflicts with the generic Scrum approach was delivered within *Specifying Learning*, and P1 was eventually rejected.

3.3 The second AR cycle

The 2nd AR cycle corresponded with a bulk of Sprints (9) across the academic project and led to delivering a preliminary version of the Scrum approach adjusted for 'ad-hoc' IT projects. Given revealed limitations, the cycle was fueled by two working research propositions: (P2) *the Scrum framework can be adapted for the successful execution of*

'ad hoc' type projects; and (P3) *Development Team membership fluctuations shall require significantly more extensive documentation of functionality*.

From this moment on, monitoring the course of the project regarding the schedule and progress of work on Product Backlog Items (PBIs) ran in the background. It was the Scrum Master who was the primary person responsible for identifying sources of inefficiency; he had the support of an experienced Product Owner in coming up with proposals to address those. *Action Taking* involved both field-testing the proposals and ongoing ratification of the components of the approach based on three questions discussed with the entire Development Team after each Sprint review: (1) Which project management activities do you consider the most beneficial? (2) Which project management activities are the least beneficial for you? (3) What other activities would you integrate into the project execution process to make it more efficient?

To avoid embellishment and maintain the integrity of received responses for all of the conducted surveys we used a deductive analysis. This allowed us to make sense of interview respondents' individual stories via the narrative analysis method, mapped with structured or predetermined categories in advance. Therefore, we mapped connections in the data to distinguished categories strictly related to the aforementioned connections [44]. For instance, the first questionnaire came with such categories as: the most beneficial project management activities, the least beneficial project management activities, and missing project management activities.

Upon the project's completion, *Evaluating* the customizations featured a few interrelated steps. First, structured, in-depth interviews with the Scrum Master and all members of the Development Team were conducted to assess the project from two perspectives: the efficiency of the project management approach used and the quality of the final product. The questionnaire form to validate the former featured eight questions with the option of providing narrative feedback:

1. Are Sprint planning mechanisms appropriate?
2. Do the formulas for calculating the duration of a Sprint allow for precise measurement?
3. Does the lack of a Daily Scrum have a negative impact on project performance?
4. Do virtual synchronous and asynchronous communication solutions enable effective communication in the project?
5. Does the possibility of increasing the length of Sprints harm the efficiency of project execution?
6. Does discontinuing the practice obliging the members of a Development Team to participate in only one project have a negative impact on project execution?
7. Does the monitoring system detect exceptions?
8. Are project templates suitable for carrying out project tasks?

Secondly, a Q&A session was held to gather more detailed information on possible concerns. The quality of the final release of the mobile solution was assessed both internally and from the perspective of the end-user. The procedure for collecting feedback from Development Team members was again based on sessions including questionnaire forms and extensive discussion. Two open questions were addressed: (1) How would you rate the completeness and consistency of the application's functionality? (2) How would you rate the quality of the application in terms of readability of the layout, consistency of navigation mechanisms, intuitiveness of interaction with the user interface, as well as user-friendliness of solutions used for data visualization?

Hence, the former question was aimed at assessing the functionality of the final product, while the latter addressed the user experience associated with using it. As for the end-user perspective, the quality of the mobile solution was confirmed by both students and lecturers of the Faculty of Management. Altogether, 132 end-users (121 students and 11 lecturers) of the product expressed their opinions during face-to-face group interviews lasting from 15 to 30 minutes. They were approached with the same questions as the Development Team across a two-month-long timeframe. *Specifying Learning* of the 2nd AR cycle ended with accepting P2 and only partially accepting P3.

3.4 The third AR cycle

Further development and tuning in the proposed approach were based on a Diagnosis that (P4) *the specificity of commercial projects with a significant share of numerous geographically dispersed external partners falls into the 'ad hoc' category*; and (P5) *the scale of commercial projects and their strict deadlines may require further adaptation*. The layout of the 3rd AR cycle closely mirrored the 1st cycle up to the *Evaluating* phase across 17 Sprints. Yet, following the propositions the project setting shifted to commercial: a large electricity supply company was provided with a responsive web application for monitoring infrastructure investments. Depending on Sprint, the number of Development Team members fluctuated from 9 to 14. For its entire timespan, one backend senior software engineer (8 years of experience), and one frontend senior software developer (11 years of experience) were part of the project. Also, depending on Sprint there were 5 mid-developers (3-6 years of experience) and 9 junior developers (1-3 years of experience). The essential web system development component was carried out over fourteen months. Users of the system are employees representing infrastructure development departments, inspectors of investment progress, and the top management of the electricity supply company that employs over 8,700 professionals. The target solution was successfully integrated with the IT solutions used to date – namely, SAP (Systems Applications and Products in Data Processing) and SID (Distribution Information System). The project fully met the 'ad-hoc' IT project specificity:

- Scrum was used as a project management approach in which the development team consisted of twelve members on average.
- The Development Team was significantly distributed. System analysts and designers, front-end developers, back-end developers, testers, and product owner were employed by two universities and four companies. All members were located in different cities, a few hundred kilometers from each other.
- The team was virtual. Members of the Development Team conducted 94% of synchronous communication via video conferencing using Skype or Skype for Business. Project management was supported by JIRA and Google Drive.
- Participation in the project was 'ad-hoc'. Individuals' involvement in the project was an additional job, even though most of them devoted at least a dozen hours per week to it.

That said, both projects covered by the research differed in size and duration constraints. The academic project was relatively small, with no strong time pressure, whereas the commercial one featured a large scale and a strict deadline.

Action Taking confirmed the general adequacy of the agile software development approach for 'ad-hoc' IT projects elaborated during academic initiative for use in described conditions. Participation in the commercial project was not part of the regular work of team members. Therefore – such as the students – the professionals had very limited time available to carry out project tasks. Team meetings were also affected by numerous restrictions, and thus had to be very irregular. This setting forced the decision to run the project as a virtual team (which constitutes another similarity), with (a)synchronous communication limited to that provided by dedicated software without the benefit of direct meetings.

Evaluating incorporated procedures and questionnaires used previously in a student-exclusive environment (see section 3.3). The assessment was conducted by 43 employees from various departments and six branches during seven face-to-face meetings. As of the *Specifying Learning* phase, adaptation of communication methods, a revised Sprint calculation formula, and an updated list of reservations were introduced. Ultimately, both P4 and P5 were accepted.

4. Results

4.1 Academic project

As soon as feedback gathered during the 1st AR cycle contradicted that the generic Scrum constituted a good fit for enhancing the maturity of the university application ecosystem by student teams that run 'ad-hoc' projects, academic project contributors embarked on a systematic assessment of activities that exist under Scrum. In particular, conducting project meetings at fixed periodical dates (with no option to seamlessly swap team members) was considered detrimental (Table 1).

Table 1. Project realization conflicts with the generic Scrum approach

Scrum assumption	Conflict with the Scrum assumption
All Scrum members are obliged to participate in daily meetings and cannot participate in other projects during Sprints.	Development Team members are engaged in the project as part of their additional jobs. Only periodic availability was declared.
There has to be a Daily Scrum in the form of a 15-minute time-boxed event for the Development Team. It enables synchronizing activities and creating a plan for the next 24 hours.	Daily meetings are not possible, and the number of participants may change over time depending on the availability of participants. Moreover, communication must be remote.
Once a Sprint runs, its duration is fixed and cannot be shortened or extended.	Since the availability of Developer Team members during a Sprint may change dynamically, it seems useful to be able to extend the Sprint length to fix disturbances instead of canceling the Sprint.
Scrum Teams are self-organizing and cross-functional. No one, not even the Scrum Master, tells the Development Team how to turn a Product Backlog into releasable functionality.	Due to loose cooperation between team members during a Sprint, there is a noticeable need for the traditional role of Project Manager. He/she constantly controls the accomplishment of tasks members of the Development Team.

Developers and the Scrum Master also pointed out activities they would like to integrate during succeeding Sprints, as they believed those to be viable solutions to problems related to the least beneficial activities. Such activities included:

- determining Sprint duration based on the average availability of team members per week (introduced after completing the 1st Sprint and developed further after the 2nd and 3rd);
- scheduling meetings one-by-one, at different time intervals and with different lengths accounted for (put to work after the 1st Sprint and extended into virtual collaboration after the 2nd one);
- periodical evaluation of the availability of Development Team members with the option of changing its structure by swapping members or hiring new ones (introduced after the 2nd Sprint and escalated after the 3rd one);
- introducing the possibility of increasing the Sprint length or shifting some of the features being implemented to the next (with the former included in the adapted approach after the 3rd Sprint and the latter upon completion of the 4th one).

The intervention-oriented nature of the AR method enabled the integration of those activities gradually into the adapted Scrum framework (Fig. 3). It is the significant tailoring of the Scrum Sprint execution that constitutes the key modification to support volatile development team collaboration. As presented in the figure, both major and minor enhancements were included compared to traditional Sprint execution (marked with a dashed line). First of all, the list of developed features was based on their duration. This contradicts the relative system used in Scrum [45]. Features were chosen according to their priority, measured as a quotient of their business value in relation to their effort. The higher the quotient value, the higher the feature priority. Such a prioritization system is in line with the generic Scrum. As this occurred at very early project stages, it aggravated the potential risk of important features, with a high expected workload, ending up getting a relatively low priority. Thenceforward, features developed within succeeding Sprints were ranked by business value. If there were features assigned the same rank value, then priority was calculated. Subsequently, the list was limited to 100 hours of work (as velocity), which must have been provided by the team members during the Sprint. Such a value was ascertained as a result of measuring members' availability during the first two months of a project. Development Team members could only allocate an average time of close to 11 hours for a 4-week-long period. Moreover, depending on the period, values differed significantly among members where deviations reached hundreds of percent.

Also, the maximum Sprint time was extended to ten weeks (instead of the usual 30 days). This decision required the consent of stakeholders regarding the time required to prepare a decent number of PBIs and was introduced after the 3rd Sprint. The justification for this change was to mitigate the risk that several Product Backlog Items would not be implemented during a Sprint due to the limited availability of certain Development Team members. Therefore, the Development Team calculated the Sprint duration based on the *100 hours / average available hours per week* formula. The formula was determined based on the analysis of the 2nd Sprint, in which few features were developed given the

intermittent availability of project team members – a total of only 57 hours per month. This means that the estimation of the Development Team velocity is project-dependent.

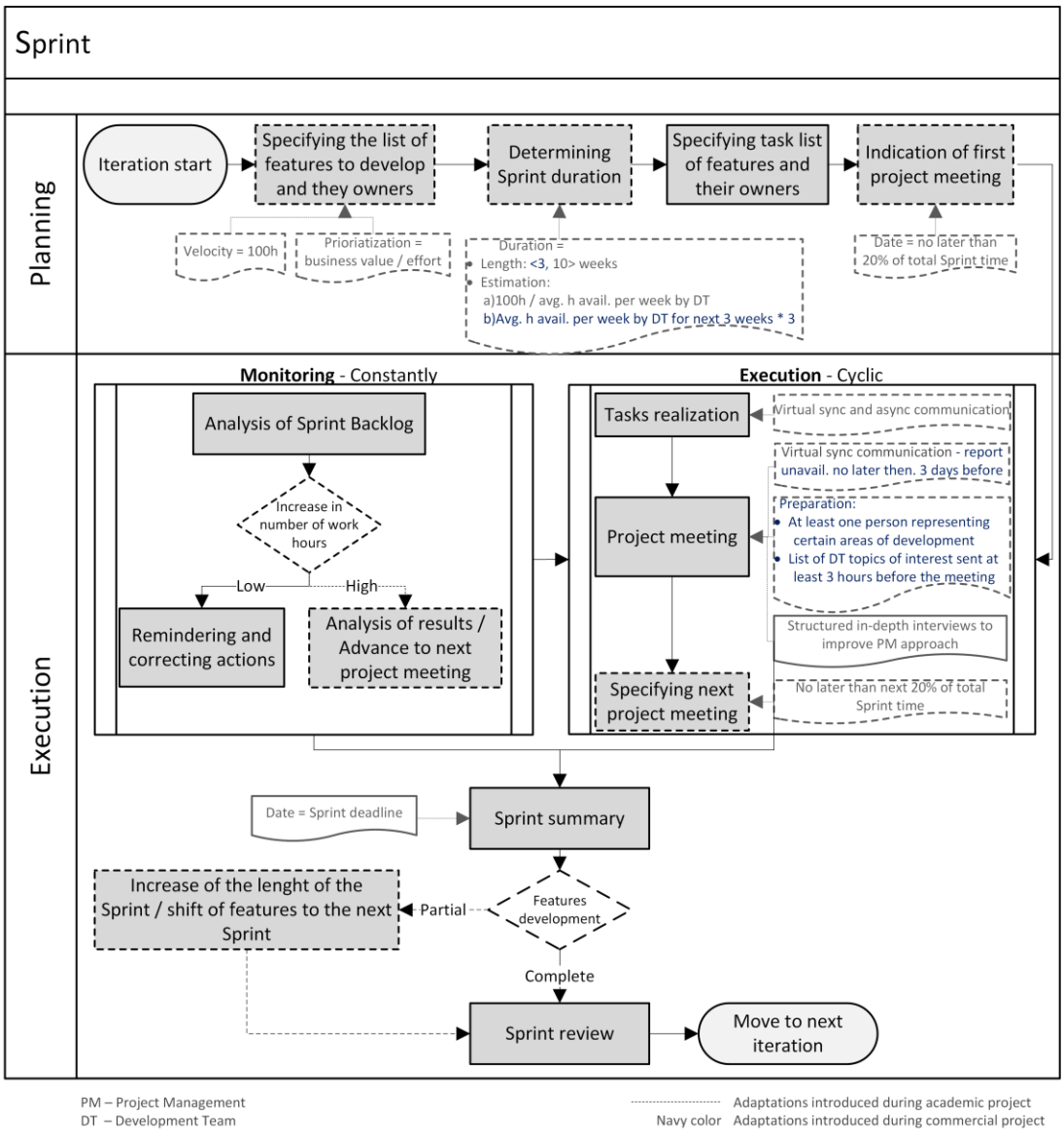

Fig. 3. Modified Sprint execution process

An important determinant of the project realization was the inability to maintain Daily Scrum (see Table 1). During the 1st Sprint, many members of the Development Team did not participate in most everyday meetings. A typical root source of the problem was that the daily schedule of meetings conflicted with other important duties associated with working or studying. All team members listed daily meetings as Scrum's activities they found least favorable. Therefore, the 1st Sprint contributed to the project management approach being adapted to periodically organize project

meetings with dates set during previous meetings (Fig. 3). To ensure the adequate number of project meetings during Sprints, the frequency of participation in daily meetings throughout the 1st Sprint was subjected to analysis. Based on the results and consultations between the Scrum Master and the Development Team, it was decided that meetings should be scheduled no later than the following 20% of the total Sprint duration. Due to the varying availability of the contributors, the exact date and time were jointly agreed upon a few days before the pre-determined date, and the action was coordinated by the Scrum Master. Beyond that, it was considered acceptable that not all members of the Development Team were required to attend a project meeting if it was not possible to find a suitable date for all of them. Such enhancement was integrated into the proposed approach after the 1st Sprint.

Many contributors were not available on-site and complained that they had to spend a lot of time traveling to participate in daily meetings instead of working on developing the mobile application functionality. To facilitate communication and allow more flexible participation in project meetings, digital communication channels were mainly used instead of traditional face-to-face meetings, becoming an integral part of the adapted Scrum after the 2nd Sprint.

The loss of the Daily Scrum caused significant changes within the project monitoring process. The Scrum approach assumes daily monitoring of the remaining working hours (which was not applied). This was dictated by the various work patterns of individual members of the Development Team, depending on their availability. The analysis of the Burndown Chart after the 1st Sprint revealed a great downtime in its update, traced back to highly varying work periods of certain contributors. Some of them had over week-long interludes in developing PBIs. Thus, the Burndown Chart proved to be of little use as a monitoring tool. Therefore, in cooperation with the Scrum Master, it was decided that the Development Team members should systematically update their working time for specific dates in the Sprint Backlog. This is contrary to generic Scrum, where working hours for given dates are set at the beginning of a Sprint, and, during its execution, the values are decreased according to the work done. The Scrum Master was to analyze the results of updates systematically. When he deemed it fitting, he could decide to proceed to the next project meeting. If the increase in the number of hours was small, the Scrum Master carried out appropriate corrective actions. Those included motivating project members, replacing contributors, or expanding the Development Team. Said tweak was integrated into the solution after the 2nd Sprint.

Per Scrum principles, each Sprint ended with a summary and review (Fig. 3). In this respect, one significant modification was introduced. When only partial implementation of specified features occurred, it was permissible to increase the length of the Sprint. The lack of daily collaboration between programmers and their intermittent availability posed a serious risk in ensuring that all functions were completed before the deadline. This was the case in the 3rd Sprint because one of the Development Team members was replaced by another developer due to a substantial failure to meet deadlines. For the third task, one contributor (MK, see Fig. 4) was substituted with another one (JL). Recruiting a new Development Team member and familiarizing one with the current state of the product under development (and the project management approach being used) prevented the development of two PBIs according to the schedule. Unfortunately, one of the PBIs was developed solely by the dismissed contributor. Hence, the basic solution that was included in the adapted Scrum approach beginning with the 3rd Sprint was to always have at least two team members responsible for a single PBI, except trivial ones.

Additionally, the Scrum Master was hereafter authorized to increase the length of the Sprint should deviations from the plan be minor, or even to transfer some of the developed features to the following Sprint without canceling the current one. He was obliged to consult first with all contributors involved in the development of PBIs that would not be prepared on time. The choice of a measure – increasing lengths or offsetting PBIs – depended on the scale of time discrepancy and was made individually for each PBI during consultations. Ipso facto, the role and responsibility of the Scrum Master was extended compared to the generic Scrum. His effectiveness in coordinating the project was recognized as a highly relevant factor for the project's accomplishment. Further empowerment of the Scrum Master resulted not only from the dispersion and virtuality of the team, the impermanent involvement of individual contributors, and the inability to conduct regular, cyclical meetings. The repeated absence of several members of the team at given meetings, even though the meetings were virtual, was another factor. The issues limiting team collaboration did not enable full self-organization of the team. Apt decisions regarding the implementation of individual

PBIs and Sprints lengths, however, were made each time after consulting selected team members who were directly affected by the problem.

As a result of the far-reaching modification of Sprinting, the 2nd element of the proposed Scrum adaptation involved customized documentation (beginning with the 3rd Sprint). This modification met the reported necessity to augment the project realization monitoring process. On top of that, a backup accountable developer for each PBI was nominated beginning with the same Sprint – and had to be precisely indicated in the documentation. Taking generic Scrum as a benchmark, the enhancements (in contrast to streamlining the Sprint execution process) simplified things. First, the Sprint Burndown Chart (usually being an integral part of Scrum-realized projects) was excluded. As already mentioned, the volatile availability of contributors meant that the information provided by the Burndown Chart was not very useful. Usually, on a given day the number of working hours devoted to given tasks was much lower or much higher than indicated by the Ideal Trend. Some customizations were included in the Sprint Backlog (Fig. 4).

"Mobile Student Schedule WZR" Application
Sprint 3 - ETL (Extract, Transform and Load) faculty data from the university website

Initial Developer Team members:	5
Duration in days:	14
Start of Sprint:	04 May

Id	Type	Task	Status	M1	M2	M3	M4	04/05	05/05	06/05	07/05	08/05	09/05	10/05	11/05	12/05	13/05	14/05	15/05	16/05	17/05
1	Design	Analysis of data structure on schedules website		AM	JL			4													
2	Coding	Programming connection and data downloading from website		AM	JL					4AM	2AM	3JL	3AM 2JL								
3	Coding	Programming data transformation and load to SOA Web Service standard		MK	JL										5	2		6			
4	Testing	Testing validity of ETL with the website		MK																1	3

.....

ID	Name	Function
1	JL, AM	Senior developer
2	MK	Developer
3	TK	Junior developer, tester
4	MK, TK	Tester
5	AM	Requirements
6	MK	Deployment
7	MK	Documentation

Status
Finished
In Progress
To do
Canceled
Bug
Other

Fig. 4. Customized Sprint Backlog example

Columns M1-M4 were added to the Sprint Backlog document to represent the initials of Development Team members accountable for handling each task. Value in the M1 column is the initials of the main person responsible for PBI's task. Values in M2-M4 columns are initials for other Development team members responsible for the task, whereas importantly muted values represent reserve person(s) for the task. The latter have basic information about a PBI, and will only contribute to task realization in case of disturbances – such as failure to meet deadlines by another member. Therefore, the proposed approach addressed the moderate risk of 'ad-hoc' projects that some project members may suddenly become unavailable. The former initials indicate the main person accountable for a PBI, whereas the latter – a deputy, should disruptions within a given Sprint implementation emerge. The initials of the contributors who were unable to continue working on the task are marked in grey. When the recruitment of a new PBI supervisor is conducted, the availability of the deputy is checked first (see Task 3 in Fig. 4). If the task's supervisor remains involved in its execution, yet support is required, an additional backup person is recruited. When more people perform the task, initials accompany the number of hours for particular dates (see Task 2 in Fig. 4). Providing such information is crucial to predict future problems and introduce corrective measures. The corresponding spreadsheet template was created and shared via Google Drive. IT solutions (e.g., JIRA) commonly used for agile project management enable only one person

responsible for each PBI to be assigned. These solutions also feature limited ability to mark Development Team members as temporarily unavailable or no longer available.

The Sprint Backlog template stores dates when the Development Team members update their working hours. This is also a result of the monitoring system adopted. As a Sprint begins, estimates for individual dates are provided in grey. Then, during the execution of the Sprint, actual values are recorded in black. If the Scrum Master detects a significant discrepancy between estimates and actual values, information on the root causes of this situation is obtained first from individual project members. Subsequently, corrective actions are conducted. Other elements of the Sprint Backlog template are consistent with the generic Scrum approach.

4.2 Commercial project

Fine-tuning the draft jointly with the professional IT community confirmed the added value of this approach in respect of:

- adaptation of the Sprint execution process (Fig. 3, marked with navy color), except for the formula for calculating a Sprint duration as well as meetings planning;
- customized Spring Backlog documentation (Fig. 4);
- crisis management methods that address the unavailability of members of the Development Team.

The *100 hours / average available hours per week* formula used to calculate the duration of a Sprint did not seem fully suitable. When planning the 1st Sprint, eleven contributors had an average availability of 13.7 hours per week every month. Thus, applying the formula would end up with a Sprint length taking just 66% of a single week. This constitutes approximately three business days, as *100 / (11 * 13.7) = 0.66*. In a setting that significantly limits the capability to organize meetings of the entire Development Team (which, in our experience, is typical for commercial projects with the close involvement of external experts), it was impossible to plan Sprints every three days. After consulting developers and the Scrum Master, it was agreed that Sprints should last at least three weeks so that Sprint planning would not take place too often. It was justified that, for shorter periods, time overhead for Sprint planning meetings would be too high regarding later development time, as commercial project development team members could allocate moderate time (several hours a week). This is contrary to the very limited availability of the Academic project developers (a few hours a week). Therefore formula "*100 hours / average available hours per week*" has been wrapped with "*at least 3 weeks condition"* (Fig. 3).

As a result, an additional formula was fashioned for calculating the minimum Sprint length based on the number of working hours of 'ad-hoc' teams with increased availability: *the average available hours per week by the Development Team for the next three weeks * 3*. In the 1st Sprint, it amounted to 452 hours – *(13.7 * 11) * 3*. The choice of one of two alternative basic formulas for planning Sprint duration depended on the average availability of the Development Team per week. Such enhancement was integrated upon completing the 1st Sprint of the commercial project.

After the initial two Sprints, the members of the Development Team highlighted the inefficiency of both the planning and implementation of the knowledge-sharing infrastructure. Communication via JIRA, emails, and video conferencing enabled cooperation between front-end and back-end developers. Unfortunately, there were situations in which interactive communication featuring screen sharing was required, involving members responsible not only for programming. Above all, it covered requirements analysis, development of business algorithms, system specification, interface prototyping, and deployment. Established communication patterns, where a determination of the next date of the entire Development Team meeting is based on the analysis of the advancement of PBIs, revealed that:

- some contributors deliberately delayed the fruition of their respective tasks, waiting for the next project meeting to be able to consult complex or ambiguous problems with the entire team;
- scheduling difficulties required additional, synchronous project meetings of an ad-hoc nature involving the entire Development Team;
- the use of asynchronous communication tools to obtain properly correlated information from various contributors turned out to be time-consuming and, in some cases, caused misunderstandings.

To address the aforementioned challenges of sharing knowledge among contributors, after the 2nd Sprint it was decided to hold regular meetings of the entire team via videoconferencing instead of physical ones. The modification was integrated into the proposed approach (see Fig. 3, remarks regarding *Tasks realization* and *Project meeting* activities as part of the *Execution*) beginning with the 3rd Sprint. Scheduling such a meeting ought to be pursued during Sprint planning. To limit the issues arising from individual contributors canceling participation in a given meeting, all members of the Development Team were required to report this to the Scrum Master no later than 3 days before the meeting. The 2nd vital ruleset was that at least one person had to represent certain areas of system development each time, namely: requirements analysis, specification, front-end development, back-end development, testing, and deployment. Finally, members of the Development Team were obliged to provide the Scrum Master with a list of topics of interest to them at least three hours before the meeting. The Scrum Master was responsible for preparing a joint list and passing it to the entire team no later than two hours before the meeting. This minor, yet still important prerequisite was added to the elaborated approach after the 3rd Sprint.

5. Discussion

5.1 Development Team structure

Periodic assessment of Development Team members' availability proved useful for the overall performance of 'ad-hoc' projects. The frequency of taking the option to change the structure of the team slightly exceeded rough estimates. Team members who turned out to be much less available during the development of PBIs than they declared could be replaced seamlessly. This happened twice during the academic project of mobile solution development and once during the commercial one. If minor issues related to declared availability were reported by some contributors, new team members could be added – which is convergent with a study by Tekin et al. [46]. This solution was used across four student Sprints, and only once during the execution of the commercial project. Pre-planned intervention prevented shifting certain PBIs to the following Sprint or extending the current one three times. The academic project once required an emergency modification of the Sprint schedule despite extending the team. Strict adherence to the generic Scrum framework would not allow such an event and would imply abandoning the Sprint and restarting the whole scheduling process. Such results build upon reports from Heikkilä et al. [11] and Rolland et al. [29], who considered the stability of a Development Team an important aspect of strategic planning during project vertical scaling. Therefore, retaining the Development Team structure might be considered project size-dependent.

5.2 Sprint execution

The admissibility of lengthening Sprints (or shifting some of the features under development to succeeding ones) also gained much traction in challenging real-world settings. Apart from holding additional flexibility in high esteem, project members highlighted a lower degree of frustration that the scheduled number of PBIs during the Sprint could not be developed compared to previous projects. Naturally, delaying the development of PBIs or extending Sprint timespans generally has a negative impact, especially if it occurs frequently. Such action cannot be automatic, and it should be preceded by a detailed Sprint execution analysis. The student project featured a single situation of transferring PBIs to the following Sprint. On two occasions, the Sprint was stretched. Including such a feature in the structure of Sprint prevented it from being canceled and avoided spending extra time planning a new one. The time needed to reorganize the Sprint schedule in the 'ad-hoc' setting simply proved considerably shorter. Moreover, to make up for the delay resulting from re-scheduling/shifting PBIs, further human resources were secured beforehand for the next Sprint.

Transferring PBI development to subsequent Sprints was not necessary in the commercial setting, and the need to extend the Sprint happened twice. The latter concerned the first two Sprints and resulted from communication patterns in force at that time – where the determination of the next date for the entire Development Team meeting was based on an analysis of PBI progress. The proposed modification of the framework approached the problem by planning regular meetings of all participants via videoconferencing once a week. Our results, highlighting the necessity to ease restrictions related to Daily Scrum, are consistent with a few other studies concerning Scrum adaptation for distributed

organizational settings [10],[15]. However, in contrast to these, the level of relaxation is much higher – project meetings can be held even only once per week. This is justified by the 'ad-hoc' features of IT projects.

Ensuring that (1) representatives of each area of system development must always be present during online meetings; and (2) a list of reported topics is to be sent to the Development Team members before the meeting were another two interventions that nipped the recurring issue of extending Sprints in the bud. Narrowing down the number of Development Team members obliged to take part to the representatives of given areas only is a new solution that is not brought up in other studies [2],[31],[15].

5.3 Benefits of the adapted Scrum approach

The Development Team members highly rated the modified Scrum approach with respect to its use in 'ad-hoc' projects. All twenty-one developers representing both projects provided convergent responses to the entire set of questions (Table 2). This clearly indicates that the enhancements introduced were perceived as alike. As projects met their original deadlines, the proposed Scrum adaptation alone did not lead to exceeding the premeditated durations of product delivery – what is beyond doubt a risk accompanying the introduction of organizational change. In our opinion, the reason for receiving highly consistent feedback on evaluation questions was related to the method chosen for tailor-fitting the project management approach. AR method enabled continuous improvement by introducing new components after each Sprint within successive cycles, owing to observations and extensive consultations. Any method that would assume a linear scenario of *approach adaptation → holistic implementation → final assessment* would be unlikely to be rated as favorably. The study implies the legitimacy of loosening some Scrum principles within 'ad-hoc' projects. These include keeping a strict daily meeting routine, retaining planned Sprint lengths, and enforcing Development Team stability while running Sprints.

5.4 Risks associated with the approach

Even though the approach was positively validated, we carefully considered the concerns that were raised in the final stages of the 2nd and 3rd AR cycles. Three students expressed the view that accepting reshuffles in the team structure during Sprints as a normal practice makes developers feel less connected to the project and reduces the call of duty (see Table 2). Similar feedback was not recorded during the final assessment of the approach after the commercial project. We believe that this inconsistency was caused by having just a single replacement of the developer in the latter case. Moreover, each professional was engaged in the venture for at least several hours per week. Sweeping fluctuations in the structure of the Development Team constitute a possible negative effect of our solution. Therefore, it seems reasonable to allow the structure of the team to change during a Sprint, yet treat it as an emergency solution only.

Replacing Development Team members with new ones requires additional time to become familiar with the project and its setting. Also, it might enforce (be beneficial) to recalculate the Development Team velocity before/during Sprint (Table 2). The negative impact of this situation is unavoidable. The primary solution to reduce such a drawback is to document the project to a slightly greater extent than is traditionally found in Scrum. Typically, lean documentation is created; both in terms of specifying functionalities to be implemented and code delivered already. The academic project featured an attempt to incorporate a light version of Unified Modeling Language for providing a system overview and sequencing crucial Use Cases to enhance cooperation among system developers, yet this proposal proved too far-reaching and was rolled back. Real-life conditions demonstrated that the documentation ought to be detailed just enough to enable the successors of PBI developers to pursue implementing PBIs being taken over on its basis. The class structure might be recreated after actual implementation using reverse-engineering functionality of contemporary CASE tools if needed. It is also vital to have communicative team members, and always ensure that at least two people are familiar with each topic. Such an approach is original to our Scrum adaptation, as it was not featured in other reported cases [11],[9],[15],[29].

Minor negative comments addressed the capability of stretching some Sprints by members of the student project. Four contributors highlighted that allowing PBIs to be moved to the next Sprint or extending lengths could harm overall project performance. Developers might be less motivated and even effective, as they are aware that the development of

PBIs can always be shifted – so that other duties can be treated as having higher priority. The same opinion was expressed by only a single contributor to the commercial project, who noted that projects running simultaneously and requiring one's input could be considered more important for the same reason. Across both ventures, the Scrum Masters' motivational skills were at a level high enough to avoid such drawbacks. If the Scrum Master were a mediocre motivator, this might become significant. Therefore, in our opinion, PBI relocation between Sprints should be limited to the features of secondary importance. These conclusions are partly divergent from previous studies [12],[9] that highlight the need to maintain consistency in the implementation of Sprints. Therefore, the proposed feature of our Scrum adaptation should be considered particularly valuable for small and medium software development projects. For large initiatives, a prior individual assessment of this adaptation's usefulness should be conducted.

Table 2. Validation of the approach – feedback summary

Question	Feedback	Comments
Are Sprint planning mechanisms appropriate?	Yes	
Do the formulas for calculating the duration of a Sprint allow for precise measurement?	Yes	The academic project only: ▪ Might be beneficial if the Development Team velocity is recalculated before each Sprint especially if the team structure significantly changes.
Does the lack of a Daily Scrum have a negative impact on project performance?	No	Both projects: ▪ Could have a negative impact on less motivated Development Teams.
Do virtual synchronous and asynchronous communication solutions enable effective communication in the project?	Yes	
Does the possibility of increasing the length of Sprints harm the efficiency of project execution?	No	Both projects: ▪ Possible negative impact on overall project performance – developers might be less motivated. ▪ Other projects featuring a less flexible approach to project management may be prioritized.
Does discontinuing the practice obliging the members of a Development Team to participate in only one project have a negative impact on project execution?	No	Academic project only: ▪ Developers feel less connected with a project. ▪ Additional time is required to familiarize developers with the project and its setting.
Does the monitoring system detect exceptions?	Yes	Academic project only: ▪ Possible deterioration of the quality of test cases – additional workflows are required to fix bugs and optimize source code.
Are project templates suitable for carrying out project tasks?	Yes	

As the monitoring system is concerned, the most significant reservations were raised by members of the academic project. Although it was rated positively overall, three of the contributors linked the changes in the Development Team to the quality of test cases. Potential frequent fluctuations in membership contributed to shifting the elaboration of test cases to the final, rather than to the early stages of development of individual functionalities. Should the developers tasked with implementing given PBIs be replaced, their successors would prepare test cases covering the functionality they did not develop themselves. The study revealed this led to deteriorating the overall quality of test cases. Therefore, assuring high-quality target software required additional workflows to fix bugs and optimize application code. The

natural reason for this state of affairs is that newly introduced team members have limited knowledge of previous work – including whether the PBI-related source code already written was tested and optimized or not.

Moreover, the likelihood that the added value provided by new developers ceases the existing code to work properly proved to be greater than in traditional teams. Test-driven Development (TDD) was the countermeasure introduced during the 4th Sprint. Despite that, two members of the team found this insufficient. Therefore, additional solutions should be explored. Again, this issue was not raised by the members of the commercial project.

6. Implications and limitations

Research results allow several implications to be pointed out. To begin with, the adapted Scrum approach supports the accomplishment of software development projects by enthusiasts – who run such projects during their spare time, which is difficult to predict. Whereas half of the proposed Scrum adaptations were equally suited to non-commercial and commercial 'ad-hoc' software development projects executed by distributed teams with highly fluctuating structures, some of them constituted a better fit for the former (Table 3). A bulk of variations associated with running Sprints result from fluctuations in team membership, and these are more common in volunteer-based projects. One reason is that there is no link between the success of a project and the remuneration of contributors.

Table 3. Comparative analysis of adaptations' fit

Scrum framework adaptation		**The setting of a project**	
No.	**Description**	**Non-commercial**	**Commercial**
1	Option to change the structure of the Development Team Structure during a Sprint	*Highly useful*: The lack of financial dependence causes frequent disruptions in the structure of the team, even during Sprints.	*Moderately useful*: Employee contracts in place reduce the risk of Development Team membership fluctuating during Sprints.
2	Ascribing backup accountable developer to each PBI	*Highly useful*: provides a viable tool to counteract frequent fluctuations in the structure of the Development Team.	*Moderately useful*: In this setting, developer substitutions are relatively rare.
3	Option to extend the duration of a Sprint	*Useful*: The time needed to reorganize the Sprint schedule in 'ad-hoc' settings is usually shorter than to cancel it and initiate planning another one; a more useful solution than the PBI shift (#4), which requires securing additional human resources beforehand.	
4	Option to shift some PBIs under development to subsequent Sprints	*Rather useless*: extending Sprint durations (#3) turned out to be a much better solution; the occurrence of such a situation is also limited by other Scrum adaptations (#1 and #2).	
5	Passing over Daily Scrum restrictions with deadlines calculated from PBI progress and holding virtual meetings	*Highly useful*: It allows scheduling and successfully conducting cyclical meetings less frequently, yet often enough for dispersed teams, in which individual members of the Development Team have significantly different availability dates.	
6	Narrowing down the Daily Scrum participants to development areas representatives only	*Highly useful*: It supports conducting cyclical meetings while retaining the capability to solve a wide spectrum of programming challenges thanks to full coverage of the required IT competencies.	
7	A slight increase in PBI documentation's level of detail and prevention of cursory descriptions of technical tasks	*Highly useful*: a tool to reduce the level of chaos in case of an emergency PBI takeover (#1).	*Moderately useful*: In this setting, developer substitutions are relatively rare.
8	Extending Scrum Master's powers towards managerial	*Highly useful*: it allows reacting faster when instability in the Development Team structure occurs (#1).	*Useful*: Although the team's stability is at a reasonable level, it facilitates the use of external competencies.

That said, both the viability of the far-reaching rebuild of a team during a Sprint and having two members ascribed for each PBI (instead of a single one) meet some challenges of contemporary companies. Not only does it address the need for the operational management of the intensive use of external contractors, but also greatly reduces the risk of derailing IT projects should a major change in a setting occur. Under normal circumstances, project teams must cope with potential changes in the responsibility of company departments or activities related to mergers, international rollouts, and acquisitions. In 2020-2021, however, a large part of the globe experienced conditions far from normal, manifested in particular by local and national lockdowns. Being equipped with a minimal amount of information about PBI that would allow taking over its realization or supporting the main developer accountable is vital when employees are let go or shifted to other duties. Even though scrutinized projects were fully realized in an agile manner, traditionally managed projects are also prone to the identified challenges of 'ad-hoc' conditions. Proposed solutions might therefore also support human resources management within waterfall-based software development initiatives.

On top of that, the tailored framework provides the means for companies to increase the flexibility of multi-project employee allocation. In such conditions, challenges with planning Daily Scrums accumulate. Although the use of videoconferencing tools is not necessary under normal working conditions in non-dispersed organizations, developers involved in several parallel projects benefit from (1) the evolution of Daily Scrum towards 'Weekly Scrum'; (2) greater flexibility in planning Sprints while maintaining transparent scheduling rules; and (3) liberalized rules of attendance at meetings. The adapted approach also facilitates the involvement of external experts who, due to their primary contractual obligations, often have planning conflicts regarding meetings. Once again, such practices increase the organizational maturity of entities highly dependent on experts outside their payrolls and the adaptability of entire organizations to potential crises that thwart earlier planning arrangements.

Therefore, the study results discussed above enabled us to answer the research question – *Can Scrum as the key representative of agile software development approaches be adapted to the successful execution of 'ad-hoc' IT projects?* Indeed, Scrum can be adapted for such projects, even though tailor-fitting of Sprint process and project documentation is not straightforward.

Conducted empirical research addressed both a small and a large IT project, whereas medium projects might potentially require adjusting formulas to calculate the maximum Sprint time. Data collection took place during software development initiatives in a single European Union member state, while several studies confirmed that culture settings might be important [36],[37]. We consider this a clear limitation of this study. Therefore, replicating the study and comparing results between developed and emerging economies is a potential direction for future research and a measure to mitigate a threat to the external validity of the study. Finally, organization-specific contingency team reconstruction constraints should be developed and integrated into the proposed approach to prevent abuse of this feature.

7. Conclusions

The study revisited restrictive assumptions of the Scrum framework across organizations with the means to run agile IT projects in 'ad-hoc' settings. Findings allow several implications to be pointed out. To begin with, the adapted Scrum approach supports the accomplishment of software development projects by enthusiasts – who run such projects during their spare time, which is difficult to predict. A bulk of variations related to Sprinting result from fluctuations in team membership, and these are more common in volunteer-based projects like open-source framework development based on volunteer contributors. One reason is that there is no link between the success of a project and the remuneration of contributors. That said, both the viability of the far-reaching rebuild of a team during a Sprint and having two members ascribed for each PBI (instead of a single one) meet some challenges of contemporary companies. Not only does it address the need for the operational management of the intensive use of external contractors, but also greatly reduces the risk of derailing IT projects should a major change in a setting occur. Being equipped with a minimal amount of information about PBI that would allow taking over its realization (or supporting the main developer accountable) is vital when employees are let go or shifted to other duties. Even though scrutinized projects were fully realized in an agile manner, traditionally managed projects are also prone to the identified challenges of 'ad-hoc' conditions. Proposed

solutions might therefore also support human resources management within waterfall-based software development initiatives.

On top of that, the tailored framework provides the means for companies to increase the flexibility of multi-project employee allocation. In such conditions, challenges with planning Daily Scrums accumulate. Although the use of videoconferencing tools is optional under normal working conditions in non-dispersed organizations, developers involved in several parallel projects benefit from (1) the evolution of Daily Scrum towards 'Weekly Scrum'; (2) greater flexibility in planning Sprints while maintaining transparent scheduling rules; and (3) liberalized rules of attendance at meetings. Therefore, vital changes introduced to the generic Scrum's Sprint included:

- Providing custom formulas to calculate the maximum Sprint time depending on the average availability of Development Team members per week.
- Introducing asynchronous and synchronous virtual communication as the primary means of conducting project meetings with additional requirements regarding attendance and topic list distribution. Especially efficient asynchronous communication methods (dedicated chat/forum-based channels/groups/teams) are important due to potentially highly fluctuating teams with members available in disjoint time slots.
- Establishing a general rule for scheduling a future project meeting during the preceding meeting but no later than the following 20% of the total Sprint duration.
- Making the Scrum Master responsible for managing the Development Team tasks.
- Empowering the Scrum Master to make decisions regarding extending Sprints in case of minor deviations from the plan.
- Enabling PBI implementation to be moved to the next Sprints.
- Adjusting generic Scrum to project setting by allowing changes within the Development Team structure during a Sprint.
- Introducing daily Sprint Backlog analysis to assess the increase in the number of working hours for individual tasks and project team members and take adequate motivational and/or corrective actions.

The adapted approach also facilitates the involvement of external experts who, due to their primary contractual obligations, often have planning conflicts regarding meetings. Once again, such practices increase the organizational maturity of entities highly dependent on experts outside their payrolls and the adaptability of entire organizations to potential crises that thwart earlier planning arrangements.

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References

[1] U. Muhammad, T. Nazir, N. Muhammad et al., "Impact of agile management on project performance: Evidence from I.T sector of Pakistan," *PLOS One*, vol. *16*, no. *4*, *e0249311*, 2021.

[2] A. W. Cram, "Agile Development in Practice: Lessons from the Trenches," *Information Systems Management*, vol. *36*, no. *1*, pp. *2-14*, 2019.

[3] D. Martinez, X. Ferre, G. Guerrero and N. Juristo, "An Agile-Based Integrated Framework for Mobile Application Development Considering Ilities," *IEEE Access*, vol. *8*, pp. *72461-72470*, 2020.

[4] A. Srivastava, S. Bhardwaj and S. Saraswat, "Scrum Model for Agile Methodology," in *International Conference on Computing, Communication & Automation*, Greater Noida, India, 2017, pp. 864-869.

[5] A. Agrawal, M. A. Atiq and L. S. Maurya, "A Current Study on the Limitations of Agile Methods in Industry Using Secure Google Forms," *Procedia Computer Science*, vol. *78*, pp. *291-297*, 2016.

[6] F. Almeida and P. Carneiro, "Perceived Importance of Metrics for Agile Scrum Environments", *Information*, vol. *14*, no. *6*, 2023.

[7] F. M. Fowler, *Navigating Hybrid Scrum Environments: Understanding the Essentials, Avoiding the Pitfalls*. New York, NY, USA: Apress, 2019.

[8] A. Raza and H. Majeed, "Issues and Challenges in Scrum Implementation," *International Journal of Scientific & Engineering Research*," vol. *3*, no. *8*, pp. *1-4*, 2012.

[9] A. Martini and J. Bosch, "A Multiple Case Study of Continuous Architecting in Large Agile Companies: Current Gaps and the CAFFEA Framework," in *13th Working IEEE/IFIP Conference on Software Architecture*, Venice, Italy, 2016, pp. 1-10.

[10] A. Przybyłek and D. Kotecka, "Making Agile Retrospectives More Awesome," in *Federated Conference on Computer Science and Information Systems*, Prague, Czechia, 2017, pp. 1211-1216.

[11] V. T. Heikkilä, M. Paasivaara, C. Lasssenius, D. Damian and C. Engblom, "Managing the Requirements Flow from Strategy to Release in Large-Scale Agile Development: A Case Study at Ericsson," *Empirical Software Engineering*, vol. *22*, pp. *2892-2936*, 2017.

[12] M. Laanti, "Implementing Program Model with Agile Principles in a Large Software Development Organization," in *32nd Annual IEEE International Computer Software and Applications Conference*, Turku, Finland, 2008, pp. 1383-1391.

[13] D. Batra, W. Xia, D. VanderMeer and K. Dutta, "Balancing Agile and Structured Development Approaches to Successfully Manage Large Distributed Software Projects: A Case Study from the Cruise Line Industry," *Communications of the Association for Information Systems*, vol. *27*, pp. *379-394*, 2010.

[14] K. Siau and M. Ling, "Mobile Collaboration Support for Virtual Teams: The Case of Virtual Information Systems Development Teams," *Journal of Database Management*, vol. *28*, no. *3*, pp. *48-69*, 2017.

[15] S. Lee and H. S. Yong, "Distributed Agile: Project Management in a Global Environment," *Empirical Software Engineering*, vol. *15*, no. *2*, pp. *204-217*, 2010.

[16] M. Kuciapski, "How the Type of Job Position Influences Technology Acceptance: A Study of Employees' Intention to Use Mobile Technologies for Knowledge Transfer," *IEEE Access*, vol. *7*, pp. *177397-177413*, 2019.

[17] N. Cerpa and J. M. Verner, "Why Did Your Project Fail?," *Communications of the ACM*, vol. *52*, no. *12*, pp. *130-134*, 2009.

[18] M. Senapathi and M. L. Drury-Grogan, "Refining a Model for Sustained Usage of Agile Methodologies," *Journal of Systems and Software*, vol. *132*, pp. *298-316*, 2017.

[19] G. Borrego, A. L. Morán, R. R. Palacio, A. Vizcaíno and F. O. García, "Towards a Reduction in Architectural Knowledge Vaporization during Agile Global Software Development," *Information and Software Technology*, vol. *112*, pp. *68-82*, 2019.

[20] P. Rodríguez, M. Mäntylä, M. Oivo, L. E. Lwakatare, P. Seppänen and P. Kuvaja, "Advances in Using Agile and Lean Processes for Software Development," *Advances in Computers*, vol. *113*, pp. *135-224*, 2019.

[21] B. Marcinkowski and B. Gawin, "A Study on the Adaptive Approach to Technology-Driven Enhancement of Multi-Scenario Business Processes," *Information Technology & People*, vol. *32*, pp. *118-146*, 2019.

[22] Digital.ai. (2022, December). *The 16th Annual State of Agile Report* [Online]. Available: https://info.digital.ai/rs/981-LQX-968/images/AR-SA-2022-16th-Annual-State-Of-Agile-Report.pdf

[23] K. Schwaber and J. Sutherland. (2020, November). *The Definitive Guide to Scrum: The Rules of the Game* [Online]. Available: https://scrumguides.org/docs/scrumguide/v2020/2020-Scrum-Guide-US.pdf

[24] V. P. Eloranta, K. Koskimies and T. Mikkonen, "Exploring ScrumBut – an Empirical Study of Scrum Anti-Patterns," *Information and Software Technology*, vol. *74*, pp. *194-203*, 2016.

[25] G. Kiely, J. Kiely and C. Nolan, "Scaling Agile Methods to Process Improvement Projects: A Global Virtual Team Case Study," in *23rd Americas Conference on Information Systems*, Boston, MA, USA, 2017, paper 13.

[26] M. Hron and N. Obwegeser, "Scrum in Practice: An Overview of Scrum Adaptations," in *Hawaii International Conference on System Sciences*, Waikoloa Village, HI, USA, 2018, pp. 5445-5454.

[27] J. F. Tripp and D. J. Armstrong, "Agile Methodologies: Organizational Adoption Motives, Tailoring, and Performance," *Journal of Computer Information Systems*, vol. *58*, no. *2*, pp. 170-179, 2018.

[28] T. Stålhane, T. Myklebust and G. K. Hanssen, "The Application of Safe Scrum to IEC 61508 Certifiable Software," in *11th International Probabilistic Safety Assessment and Management Conference and the Annual European Safety and Reliability Conference*, Helsinki, Finland, 2012, pp. 6052-6061.

[29] K. H. Rolland, V. Mikkelsen and A. Næss, "Tailoring Agile in the Large: Experience and Reflections from a Large-Scale Agile Software Development Project," *Lecture Notes in Business Information Processing*, vol. *251*, pp. *244-251*, 2016.

[30] E. Caballero and J. A. Calvo-Manzano, "A Practical Approach to Project Management in a Very Small Company," *Communications in Computer and Information Science*, vol. *301*, pp. *319-329*, 2012.

[31] M. L. Drury-Grogan, K. Conboy and T. Acton, "Examining Decision Characteristics & Challenges for Agile Software Development," *Journal of Systems and Software*, vol. *131*, pp. *248-265*, 2017.

[32] M. Tanner and A. Mackinnon, "Sources of Interruptions Experienced During a Scrum Sprint," *The Electronic Journal of Information Systems Evaluation*, vol. *18*, pp. *3-18*, 2015.

[33] O. Adelakun, R. Garcia, T. Tabaka and R. Ismail, "Hybrid Project Management: Agile with Discipline," in *International Conference on Information Resources Management*, Santiago de Chile, Chile, 2017, paper 14.

[34] J. Reiff, and D. Schlegel, "Hybrid project management – a systematic literature review," *International Journal of Information Systems and Project Management*, vol. *10*, no. *2*, article *4*, 2022.

[35] K. Remington and J. Pollack, *Tools for Complex Projects*. Abingdon, UK: Routledge, 2008.

[36] K. Conboy and N. Carroll, "Implementing Large-Scale Agile Frameworks: Challenges and Recommendations", *IEEE Software*, vol. *36*, no. *2*, pp. *44-50*, 2019.

[37] R. Vinaja, "The Scrum Culture: Introducing Agile Methods in Organizations," *Journal of Global Information Technology Management*, vol. *22*, no. *4*, pp. *309-311*, 2019.

[38] M. Logemann, J. Aritz, P. Cardon, S. Swartz, T. Elhaddaoui, K. Getchell … and J. Stapp, "Standing strong amid a pandemic: How a global online team project stands up to the public health crisis," *British Journal of Education Technology*, vol. *53*, no. *3*, pp. *577-592*, 2022.

[39] T. E. Havstorm, and F. Karlsson, "Software developers reasoning behind adoption and use of software development methods – a systematic literature review," *International Journal of Information Systems and Project Management*, vol. *11*, no. *2*, article *4*, 2023.

[40] V. Stray, R. Florea and L. Paruch, "Exploring human factors of the agile software tester," *Software Quality Journa*l, vol. *30* no. *2*, pp. *455–481*, 2021.

[41] A. Joskowski, A. Przybylek and B. Marcinkowski "Scaling Scrum with a customized nexus framework: a report from a joint industry-academia research project," *Software-Practice & Experience*, vol. *53*, no. *7*, pp. *1525-1542*, 2023.

[42] A. Alami, P. A. Nielsen and A. Wąsowski, "A Tailored Participatory Action Research for FOSS Communities," *Empirical Software Engineering*, vol. *25*, pp. *3639-3670*, 2020.

[43] M. Grabowski, J. Madej and J. Trąbka, "Using IT to Improve Efficiency of Polish Courts: An Action Research Study," in *20th Americas Conference on Information Systems*, Savannah, GA, USA, 2014, paper 5.

[44] K. Proudfoot, "Inductive/Deductive Hybrid Thematic Analysis in Mixed Methods Research," *Journal of Mixed Methods Research*, vol. *17*, no. *3*, pp. *308–326*, 2023.

[45] Y. A. Harb, C. Noteboom and S. Sarnikar, "Evaluating Project Characteristics for Selecting the Best-Fit Agile Software Development Methodology: A Teaching Case," *Journal of the Midwest Association for Information Systems*, vol. *1*, pp. *33-52*, 2015.

[46] N. Tekin, M. Yilmaz and P. Clarke, "A novel approach for visualization, monitoring, and control techniques for Scrum metric planning using the analytic hierarchy process," *Journal of Software: Evolution and Process*, e2420, 2021.

Appendix A. Acronyms

AM	Agile Methods
AR	Action Research
GVT	Global Virtual Teams
PBI	Product Backlog Items
SAP	Systems Applications and Products in Data Processing
SDM	Software Development Method
SID	Distribution Information System
TDD	Test-Driven Development
WOA	Web-Oriented Architecture

Appendix B. Action research (AR) cycles' surveys

Survey I. Ratification of the components of the Scrum approach

1. Which project management activities do you consider the most beneficial?
2. Which project management activities are the least beneficial for you?
3. What other activities would you integrate into the project execution process to make it more efficient?

Survey II. Validation of the adapted Scrum approach

1. Are Sprint planning mechanisms appropriate?
2. Do the formulas for calculating the duration of a Sprint allow for precise measurement?
3. Does the lack of a Daily Scrum have a negative impact on project performance?
4. Do virtual synchronous and asynchronous communication solutions enable effective communication in the project?
5. Does the possibility of increasing the length of Sprints harm the efficiency of project execution?
6. Does discontinuing the practice obliging the members of a Development Team to participate in only one project have a negative impact on project execution?
7. Does the monitoring system detect exceptions?
8. Are project templates suitable for carrying out project tasks?

Survey III. The quality of the final product developed via an adapted Scrum approach

1. How would you rate the completeness and consistency of the application's functionality?
2. How would you rate the quality of the application in terms of readability of the layout, consistency of navigation mechanisms, intuitiveness of interaction with the user interface, as well as user-friendliness of solutions used for data visualization?

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Abstract:
Globalization and economic volatility changed the dynamics of production chains, which required new organizational arrangements from companies, leading them to projectization. Additionally, project professionals are managing increasingly complex projects, which demand an extensive and specific set of competences. In this context, this paper aims to identify the competences of project professionals by project type. A systematic literature review was carried out using the Scopus and Web of Sciences academic databases. The research corpus consisted of 209 articles published between 1989 and 2022. As a result, this research identified 173 competences distributed in 14 different project types; some competences have a greater significance for a given project type. As a contribution, when dealing specifically with projects and competences, project professionals, companies, and educational institutions can learn about the fundamental competences by type of project, improve the processes of selection and diagnosis of the professional, adapt educational programs, or even establish plans for project professionals career.

Keywords:
competence; project type; project professional career; project management; capacity building.

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1. Introduction

Globalization and the volatility of the economy have changed the dynamics of production chains [1]. Although many organizations have consolidated structures, this scenario of changes required new organizational arrangements that led them toward projectization [2]. In this context, project management professionals are dealing with increasingly complex projects [1], which require an ever more extensive and specific set of competencies from these professionals [3], [4].

Crawford [5] states that competences can be understood as a set of attributes that include knowledge, skills, and experiences, as well as personality traits, attitudes, and behaviors. For Perrenoud [6], competence is the individual's ability to use and connect acquired knowledge and experiences in complex, varied, and unpredictable situations. Thus, project management competences are crucial for project success, as indicated by Chipulu et al. [7]. Furthermore, Fereshteh et al. [8] state that the lack of attention to competences is one of the main factors for the failure of projects.

Based on the aforementioned aspects, it can be said that the relevance of project management competences and the search for effectiveness has led to a large number of studies that have produced new research-based understandings and also to the creation of project management competence guides [5], [1]. Among the guides produced by institutions linked to the field of project management is the Individual Competence Baseline (ICB) [9] by the International Project Management Association (IPMA). This guide proposes 29 competences grouped into ten personal and interpersonal competences, fourteen technical aspects of project management, and five contextual competences, that is, strategy, governance, structures and processes, and, culture and values [9].

Another institution that created a competence guide was the Project Management Institute (PMI), which proposes the Project Management Competence Development Framework (PMCDF) guide, where three areas of competence are defined: knowledge, performance, and personal attributes [10]. In the PMCDF, the knowledge competence dimension represents what the project professional knows about project management processes, tools, and techniques [10]. Competence performance describes how knowledge is applied to satisfy project requirements. The personal competence dimension refers to the behavior to be adopted to carry out project activities, including attitude and core personality characteristics [10].

In the same line as PMCDF and ICB, the guide maintained by the Association for Project Management (APM) suggests an APM Competence Framework guide with the proposition of 27 competences [11]. In addition to these guides, among the academic studies, Pariafsai et al. [12] identified 39 project management competences for construction projects; the authors used the PMCDF [10] and the Project Manager Competence Assessment Tool [13] as a basis for the diagnosis of competences of project managers employees. Based on these models, the authors adjusted construction project management competences.

On the other hand, Moradi et al. [14] identified 98 project management competences that have different relevance according to the context and types of projects. Turner and Muller [15] point out project type refers to the nature or attribute by which a project is categorized. For example, application area, execution difficulty, and strategic importance, among others. Along the same lines, Varajão et al. [4] observed the 12 most relevant competences in information systems-type projects. Amoah and Marimon [16] used the ICB model [9] to analyze a set of unique competences for types of construction projects. In view of academic studies such as those of these authors, Kuliš [17] stated that some researchers believe that the competences of project professionals are generic. However, the author reinforces that the prevailing view is that different types of projects need different competences.

Corroborating the ideas presented by Kuliš [17], Podgórska and Pichlak [18] argue that not all types of projects can be treated in the same way due to their size, complexity, and technology, among other variables. Furthermore, Crawford et al. [63], Shenhar et al. [20], and Youker [21] argue that the type of project influences the management approach that will be applied. Still, about project typologies, Crawford et al. [63] identified 14 groups of attributes used for the types of projects that the author identified. Despite the evidence that project management competences have been extensively researched, there is no consensus on specific project management competences, as indicated by Moradi et al. [14] and Skulmoski and Hartman [22]. Thus, it can be said that this situation leads to considerable confusion when designing

effective strategies for the education, employment, and career development of professionals in the field of project management due to its scope of application [12].

Based on this context, this paper aims to identify the competences of project professionals by project type. Therefore, a systematic literature review (SLR) was adopted as a methodological strategy to achieve this aim, which is a methodological procedure that uses literature as its main source of evidence. The rationale for this choice is given by the role of an SLR in facilitating the mapping and assessment of a specific intellectual framework to develop a body of knowledge [23], [24].

As a practical result of this research, project professionals and educational institutions can know the fundamental competences by the type of project, thus planning their career, applying in practice, or adjusting the educational program. Regarding the theoretical contribution, this article highlights the relevance of treating competences according to a project type.

2. Background

Competence is demonstrated by the application of intellectual, cognitive, affective and psychomotor behavior to achieve a certain result, causing individuals to achieve superior performance [50]. For Perrenoud [6], competence is the ability of the individual to use and connect knowledge and experiences acquired in complex, varied and unpredictable situations. Rodriguez et al. [133] argue that competence is a measurable standard of knowledge, skills and attitudes, also recognized by the acronym KSA, which an individual needs to perform work functions effectively [127]. Thus, in order for someone to achieve their goals, it is necessary to apply certain knowledge, skills and have an attitude that determines the willingness to perform activities [27].

Regard project management, we can point out that it is not simple because it requires the application of several and complementary competences, and it is a standing challenge for the professional's project managers [132]. Project development has changed over time, as well as the type of competences required to become an effective project manager. According to Kerzner [128], during the first periods of project management, hard skills had a higher priority. However, soft skills became equally relevant, since the composition of the project team was no longer just for engineering people.

In an attempt to list the competences of project management professionals, entities of project management have created their own frameworks of competences. As cited before, PMI presents the guide PMCDF [10], IPMA proposes the ICB [9], and APM presents the guide APM Competence Framework [11]. For Azim et al. [41], a successful project manager uses hard skills to determine the most appropriate execution approach to the project, and soft skills to put into practice the plan and manage people to achieve project success. Therefore, hard skills in the context of project management cover processes, procedures, tools and techniques, while soft skills can be examined from the perspective of human behavior, that is, human and social skills.

In this context, Cheng et al. [134] stated that identifying the necessary competences to perform the project management function leads to excellence in the performance of this function, which is vital for the success of the project and for organizations [135]. That said, for the development of competences it is necessary to use tools for diagnosing them to identify in project professionals competences considered strengths and competences considered weaknesses. Thus, the professionals' diagnosis will help determine how these competences can be improved or developed ([10]; [90]; [136]).

Although the importance of competences is recognized in a generalized way, Skulmoski and Hartman [22] and Moradi et al. [35] argue that there is no consensus regarding the specific competences in project management. According to Kulis [17], some researchers, such as Birkhead et al. [129], Liikamaa [130] and Ekrot et al. [131], believe that the competences of project professionals are generic. On the other hand, Crawford et al. [19], Shenhar et al. [20] and Youker [21] state that different types of projects need different competences. The type of project, according to Turner and Muller [15], refers to the nature or attribute by which a project is categorized, for example, area of application, difficulty of execution and strategic importance, among others.

With regard to diagnostic competences tools, Fereshteh et al. [8] used the PMCDF competence guide as a premise to assess the competences of project professionals. The authors grouped professionals into different levels using 12 criteria of importance to determine the score of the project on which these professionals work. Other entities, such as the American Management Association (AMA), present their AMA Skill Assessments AMA [138] diagnostic model, which diagnoses the competences needed to meet business demands based on a set of 36 statements.

Additionally, Brahim and Lassad [137] proposed in their invention patent an evaluation questionnaire that makes it possible to compare the diagnosed competences against the target of the pre-established competence, in this way, it is possible to identify the gaps in the professional's competences. Although these diagnostic instruments are presented, it is necessary to understand the relationship between competences and specific project typologies. In this sense, this article responds to this research opportunity. The next section presents the methodological approach.

3. Research design

The research adopted an SLR as a method to understand the relationship of the project manager's competences according to a typology that allows the understanding of specificities in each project. Therefore, it is necessary to understand that an SLR differs from traditional narrative reviews because it adopts a systematized scientific procedure that is replicable and transparent [24]. Thus, its use is justified by minimizing bias in the construction of a theoretical corpus and by enabling the audit of the decisions and procedures applied [25].

An SLR also differs from bibliometric studies in its more qualitative bias, since content analysis procedures are applied to categorize the research corpus based on critical and reflective reading [24]. In order to carry out this SLR, the method proposed by Pollock and Berge [23] was used, including the following stages: (i) Clarify objectives and goals; (ii) Find relevant research; (iii) Collect data; (iv) Analyze the quality of studies; (v) Synthesize the evidence; (vi) Interpret the findings. We emphasize that the first stage refers to the question that guides this research, which is: “What competences of project professionals are adherent to each type of project?”. In this sense, the Scopus and Web of Sciences academic databases were used.

The search in the databases was carried out on April 1, 2022. The string adopted to carry out the searches were: ((competenc* OR (hard AND skill) OR (soft AND skill)) AND ((kanban OR (project AND manag*) OR agile* OR scrum))). In order to obtain greater amplitude and mastery in the construction of this base, Boolean operators “and” and “or” were used, as well as the symbol “*”. The latter incorporates variations in the word in the position after which it is found. Therefore, following the protocol prescribed by Pollock and Berge [23], the body of analysis was constructed as shown in Figure 1.

In the eligibility phase, filters were applied to delimit the base of articles corresponding to the proposal of this study. Subsequently, the databases were imported by the Rayyan software, which is a tool that helps to streamline the initial screening of abstracts and titles using a semi-automation process. The software allows the consolidation of databases and the removal of duplicate articles [26]. Thus, with the consolidation of the database and the removal of duplicate articles, we read the titles and abstracts of available articles and applied the inclusion and exclusion criteria. As a result, we exported a full-read article database containing 314 articles.

The Rayyan database with the 314 selected articles was exported to a spreadsheet in Microsoft Excel software. This phase of the research allowed the categorization of contents based on the full reading of the articles. It is worth mentioning that at this stage, 105 articles that did not adhere to the researched topic were removed. Thus, the remaining 209 articles were analyzed using Microsoft Excel software. This software made it possible to perform data analysis and present the results of the combination of quantitative information by frequency analysis. This research phase also allowed us to present a relevant descriptive analysis of the study carried out.

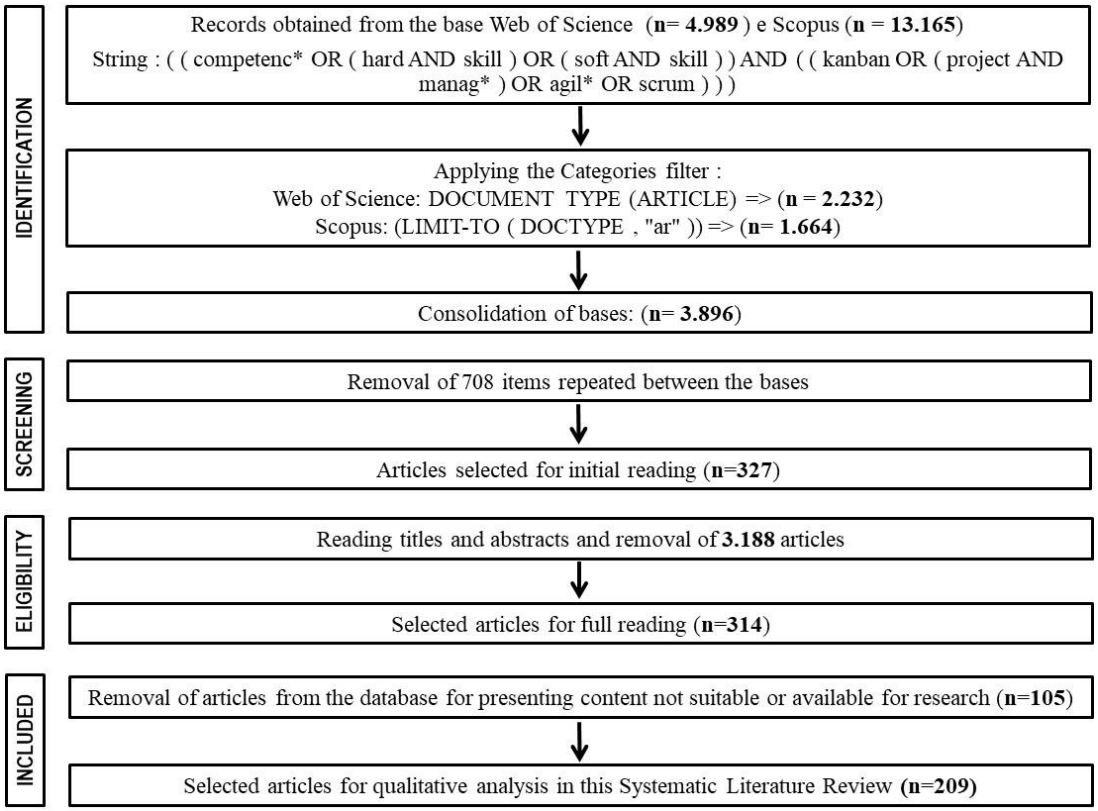

Fig. 1. Results of searches in the databases adapted from [23]

Thus, we emphasize that the last phase of this research was an analysis through in-depth reading of the corpus, which was composed of 209 articles. Following the reading of the articles, the next step was to group the articles by type of project. It is important to clarify that the initial analysis process of the articles was individual. Then, for the selection of the types of projects, the researchers of this research were inquired. The categorization process was carried out through discussion and the establishment of a consensus on the categories constituted by each of the articles [27]. At the end of the categorization process, the process of identifying competences by type of project was then conducted.

The process of analyzing and categorizing competences by type of project observed the following steps. First, the competences were regrouped according to their meaning, thus constituting a standardized competence matrix with the competence name and description. After grouping the competences for each type of project, the next step was to identify which competences are not mentioned in the competence guides presented in this study, namely PMCDF, ICB, and APM.

For this, the meaning of each of the competences was associated with the competence presented in each of the guides. During the association process, it was possible to know whether the competence extracted from the research corpus was contained in each guide. In the case of the absence of this competence in each of the guides, it was identified that there was a competence gap. In summary, at the end of the analysis process, it was possible to identify each type of project, their respective competences, and competences not mentioned in the guides.

4. Analysis of results

This section presents the results of this SLR after performing the collection and analysis processes. Initially, the mapping of the articles that constituted the research corpus was presented. Subsequently, the categories highlighted are reported after an in-depth analysis of the content of the articles.

4.1 Mapping of Articles

The articles selected from the Web of Science and Scopus academic databases were selected, and the research corpus consisted of the articles present in journals, as shown in Table 1.

Table 1. Analysis of Articles by Journals

Journal	Number of articles	%
International Journal of Project Management	22	11%
Project Management Journal	15	7%
International Journal of Managing Projects in Business	11	5%
International Journal of Information Technology Project Management	6	3%
Sustainability	6	3%
Revista de Gestão e Projetos	5	2%
Construction Management and Economics	4	2%
Engineering, Construction and Architectural Management	4	2%
Up to 3 Published Articles	136	65%
Total	**209**	**100%**

Table 1 shows 209 articles from 122 journals, with 35% of these journals having four or more publications and 65% with less than three publications per journal. This table also presents three journals that published 11 or more articles, that is, 23% of the articles published. The journal International Journal of Project Management published 22 articles, 11% of the total published on the subject, according to this research. It is worth noting that most studies are focused on project management, sustainability, engineering, and construction journals.

After mapping the metadata of the articles that constituted the research corpus, the articles were organized according to their respective years of publication. Still, at this stage of the analysis, the researchers carried out an in-depth analysis of the content of each article. Thus, reading and categorizing the contents led to the classification of articles into 14 types of projects that are presented in Table 2. It is worth noting that this research started from the premise that different types of projects require different sets of competences. In this sense, we explain that even though there are points of intersection between the types of projects and an abundance of competences described, the intention here is to propose that project management be treated in a more specific way concerning its typology.

The justification for this choice is that the competence of project professionals is affected by the context in which this professional works. Among the context variables, it can be mentioned industrial sectors, countries, regions, and the type or scope of the project [28]-[31]. Furthermore, the competence guides produced by associations such as PMI, IPMA, and APM indicate a wide range of competence elements considered the main attributes of the project manager [32]. However, the guides are designed to be applied generically, regardless of the nature, type, size, or complexity of the projects being managed [31]-[34].

Therefore, it was decided to adopt the categorization by type of project, which in the context of this study comprises fourteen types of projects obtained by an abstraction process that allowed a categorization that somehow distinguished each one of them. There are differences between the different types of projects and the requirement for specific competences for their management, or even for selecting people to compose each type of project. For example, in projects of the construction type, greater importance is given to being *Open to New Experiences* [35]; and, for projects of the Complex type, the competence of *Flexibility* is crucial [36].

Project Type / Year	Remote Teams	Telecommunications	Industry 4.0	Multiple Projects	Third Sector	Sustainability	Research and Development	Complex	Education	Public Government	Services	Software Development	Information Technology	Construction Industry	Total
1989												1			1
1992														1	1
2000														1	1
2001														1	1
2003							2				1		1		4
2004														2	2
2005														3	3
2006		1		2					1					1	5
2007										1				1	2
2008	1			1				2			1			3	8
2009		1							1				1	5	8
2010								1					3		4
2011									2		1	2	3	4	12
2012										1				1	2
2013						1	2	1			1			1	6
2014											1	1		2	4
2015					1								2	2	5
2016						1		1	1	1	1		3	5	13
2017								1		3	1		2	3	10
2018					1		1		2		3	1	1	4	13
2019	1							1	1	1	2	4	1	4	15
2020			2					1	1	2	2	2	1	5	16
2021			1		1	2		2	2	3	1	7		14	33
2022							1							3	4
Total	2	2	3	3	3	4	6	10	11	12	15	18	18	66	173
Part.	1%	1%	1%	1%	1%	2%	3%	5%	5%	6%	7%	9%	9%	32%	100%

Table 2 shows that the types of projects in the Construction Industry represent 32% of the studies; the rest of the studies are distributed over the other 14 types of projects with less than 9% each. Among the 14 types of project types, 11 of them have less than 18 articles published between 1989 and 2022, and five types have only three or fewer articles published in the same period, they are: Remote Teams, Telecommunications, Industry 4.0, Multiple Projects, and Third Sector.

The selected articles resulted in 173 competences, and the 14 most cited competences are presented in Table 3.

Table 3. List of Competences

Competences with more than 15 citations	**Citations**
Communication	129
Leadership	65
Technical Abilities	54
Interpersonal Relationship	47
Emotional intelligence	46
Monitoring and Control	41
Analytical Thinking	35
Negotiation	34
Conflict Management	33
Risk and Uncertainty Management	33
Stakeholder Management	33
Information Technology Abilities	33
Problem-Solving	31
Reliability	30

It is worth mentioning that 30 competences identified in this study were mentioned only once by the authors, such as: Digital Skills of the Fourth Industrial Revolution [37], Range of skills [100], and Management of Multiple Projects [38].

4.2 Analysis of the project types found

Based on the reading of the articles, the researchers sought to understand each of the 14 types of projects and their respective competences. For each type of project, a list of competences adhering to the type of project is presented, the competences present in the PMCDF, ICB and APM guides, in addition to the competences absent in the respective guides. The complete list of existing competences by project type can be found in the appendix.

4.2.1 Project Type – Complex

Complex-type projects are those characterized by the unpredictability of their variables. There are no apparent right answers, and analyzing the situation requires many competing ideas, thus making it difficult to implement a plan. The difficulty in managing the various variables is due to a series of uncontrollable variables and a high degree of project risk [39]-[41], [18]. In this type of project, 39 competences were identified, 31 of which are common in the guides: PMCDF, ICB and APM. Table 4 presents the list of the competences found.

Table 4. List of Competences - Project: Complex

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Adaptability	x	x	x	x	x	
Analytical Thinking	x			x	x	
Change Management	x			x	x	
Communication	x	x	x	x	x	
Conscientiousness	x			x	x	
Contract Management	x	x	x	x	x	
Cooperation	x	x	x	x	x	
Cost Management	x	x	x	x	x	
Curiosity	x			x	x	
Decision Making	x	x	x	x	x	
Dedication	x	x	x	x	x	
Emotional intelligence	x	x	x	x	x	
Empathy	x	x	x	x	x	
Empowerment	x	x	x	x	x	
Flexibility	x	x	x	x	x	
Motivation	x	x	x	x	x	
Negotiation	x	x	x	x	x	
People Management	x	x	x	x	x	
Phronesis	x		x			
Proactivity	x	x	x	x	x	
Routine Management	x	x	x	x	x	x
Purchasing Management	x	x	x	x	x	
Quality Management	x	x	x	x	x	
Resource Management	x	x	x	x	x	
Results Orientation	x	x	x	x	x	
Risk and Uncertainty Management	x	x	x	x	x	
Schedule Management	x	x	x	x	x	
Scope Management	x	x	x	x	x	
Self-awareness	x	x	x	x	x	
Self-taught	x			x	x	
Sensibility	x	x	x	x	x	
Social responsibility	x			x	x	x
Stakeholder Management	x	x	x	x	x	
Strategic Thinking	x			x	x	
Systemic View	x	x	x	x	x	
Team management	x	x	x	x	x	
Technical Abilities	x	x	x	x	x	
Vision	x	x	x	x	x	
Totals	**38**	**30**	**32**	**38**	**38**	**2**

The following competences were not mentioned in the all the analyzed guides: Self-taught, Change Management and Social Responsibility presented in the study by Li et al. [42]; Conscientiousness, Analytical Thinking and Strategic Thinking described in the research by Podgórska and Pichlak [18]; the Curiosity competence was indicated by Havila, Medlin, and Salmi [43]. Although these competences are mentioned in the ICB and APM guides, they are not mentioned in the PMCDF guide. On the other hand, the Phronesis competence, described as relevant by Bouwman and Brohm [39], is present in the PMCDF guide but is not mentioned in the IPMA and APM guides. Phronesis competence, according to Bredillet et al. [44], is to act practically depending on the context, using patterns and similarities from the experience of the project professional. In addition, complementing Bouwman and Brohm [39], these professional makes combined use of elements such as: experience, and accurate understanding of relevant details.

Also, two competences specific to this type of project (exclusive) were identified: Routine Management and Social Responsibility [23]. For Ward and Chapman [45], the competence of Routine Management means knowing how to operate the project execution regularly to influence the design, basic stakeholder issues and project objectives. The other exclusive competence is Social Responsibility, which, according to Silvius and Schipper [46], represents the ability to consider in an integrated way the elements of: health, safety and environment, environmental protection, public welfare, and community activities within the scope of the project. In this way, the absence of this competence affects the project professional's decision criteria during the project life cycle, which can cause social, health, safety, or environmental impacts on the project's stakeholders.

This type of project requires the project professional to act effectively in a constantly evolving project context with various uncertainties [47]. In addition, this type of project makes the construction of a plan to achieve the goals more challenging [48]. In this scenario, the Phronesis competence is used as a form of response [39]. Furthermore, this type of project requires the professional to act regularly and frequently, making use of Routine Management competence to address basic stakeholder questions [45], in addition to integrating different aspects of the project with Social Responsibility [46].

4.2.2 Project Type - Software Development

Projects of the Software Development type are related to the provision of software development lifecycle programming services [49], [50]. In this type of project, 51 competences were identified, 44 of which are common to all the guides: PMCDF, ICB and APM. Table 5 presents the list of the competences found.

Table 5. List of Competences - Project: Software Development

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Adaptability	x	x	x	x	x	
Agile Mindset	x				x	
Analytical Thinking	x			x	x	
Attitude	x	x	x	x	x	
Business Skills	x	x	x	x	x	
Collaboration	x	x	x	x	x	
Communication	x	x	x	x	x	
Conflict Management	x	x	x	x	x	
Context Analysis	x	x	x	x	x	
Continuous Improvement	x			x	x	
Cooperation	x	x	x	x	x	
Cost Management	x	x	x	x	x	
Critical Analysis	x	x	x	x	x	
Critical Thinking	x				x	
Cultural Intelligence	x	x	x	x	x	
Customer Focus	x	x	x	x	x	
Decision Making	x	x	x	x	x	
Effectiveness	x	x	x	x	x	
Emotional intelligence	x	x	x	x	x	
Empowerment	x	x	x	x	x	
Engagement	x	x	x	x	x	
Ethic	x	x	x	x	x	
Experience	x	x	x	x	x	
Feedback Skills	x	x	x	x	x	
Flexibility	x	x	x	x	x	
Foreign language	x	x	x	x	x	
Influence	x	x	x	x	x	
Information Technology Skills	x			x	x	

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Innovation	x			x	x	
Interpersonal Relationship	x	x	x	x	x	
Interpersonal Skills	x	x	x	x	x	
Knowledge Management	x	x	x	x	x	
Leadership	x	x	x	x	x	
Mentoring	x	x	x	x	x	
Negotiation	x	x	x	x	x	
Organizational Skills	x	x	x	x	x	
People Management	x	x	x	x	x	
Persuasion	x	x	x	x	x	
Proactivity	x	x	x	x	x	
Problem-Solving	x	x	x	x	x	
Project Management	x	x	x	x	x	
Reflection	x	x	x	x	x	
Reliability	x	x	x	x	x	
Results Oriented	x	x	x	x	x	
Risk and Uncertainty Management	x	x	x	x	x	
Schedule Management	x	x	x	x	x	
Stakeholder Management	x	x	x	x	x	
Strategic Thinking	x			x	x	
Team management	x	x	x	x	x	
Team work	x	x	x	x	x	
Technical Abilities	x	x	x	x	x	
Totals	**51**	**44**	**44**	**49**	**51**	**0**

For this type of project, the following competences are not mentioned in the PMCDF guide: Continuous Improvement [49],[54]; Information Technology Skills, Analytical Thinking and Critical Thinking [49]; Innovation [52], [53]; Agile Mindset [50]; Strategic Thinking [49], [53], [54].

For Cha and Maytorena-Sanchez [49], and Chen et al. [55], the Information Technology Skills refers to the knowledge and understanding of the use of software, systems, and hardware. Critical Thinking competence, according to Gray and Ulbrich [56], means gathering relevant data from a wide range of sources, probing the facts, critically evaluating the information, and looking for potential limitations. Based on this last competence, it is possible to understand the general framework to outline different options for decision-making in a prioritized way and in a temporal sequence [57].

It is worth emphasizing that the analyzed guides consider that the competences required by design professionals are the same, regardless of the approach used. However, because of the main differences between Traditional and Agile project management, the perception of the importance of these competences may vary according to the project approach adopted [54]. In this sense, companies that are migrating from the traditional to agile project approach have the opportunity to do so in a more targeted way [51].

4.2.3 Project Type - Education

Education-type projects are represented by projects that, through technology such as devices and tools, implement courses and training and improve the overall learning experience, causing a positive impact on knowledge transfer [58], [59]. In this type of project, 39 competences were identified, 33 of which are common to all the guides: PMCDF, ICB and APM. Table 6 presents the list of the competences found.

Table 6. List of Competences - Project: Education

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Adaptability	x	x	x	x	x	
Analytical Thinking	x			x	x	
Attitude	x	x	x	x	x	
Coherence	x			x	x	x
Collaboration	x	x	x	x	x	
Commitment	x	x	x	x	x	
Communication	x	x	x	x	x	
Conflict Management	x	x	x	x	x	
Creativity	x	x	x	x	x	
Critical Analysis	x	x	x	x	x	
Critical Thinking	x				x	
Cultural Intelligence	x	x	x	x	x	
Curiosity	x			x	x	
Disciplined	x	x	x	x	x	
Effectiveness	x	x	x	x	x	
Emotional intelligence	x	x	x	x	x	
Empathy	x	x	x	x	x	
Engagement	x	x	x	x	x	
Focus	x	x	x	x	x	
Foreign language	x	x	x	x	x	
Influence	x	x	x	x	x	
Information Technology Skills	x			x	x	
Initiative	x	x	x	x	x	
Innovation	x			x	x	
Interpersonal Relationship	x	x	x	x	x	
Leadership	x	x	x	x	x	
Optimism	x	x	x	x	x	
Problem Solving	x	x	x	x	x	
Project Management	x	x	x	x	x	
Reliability	x	x	x	x	x	
Resilience	x	x	x	x	x	
Responsibility	x	x	x	x	x	
Results Orientation	x	x	x	x	x	
Risk and Uncertainty Management	x	x	x	x	x	
Scope Management	x	x	x	x	x	
Self-confidence	x	x	x	x	x	
Team work	x	x	x	x	x	
Technical Abilities	x	x	x	x	x	
Systemic View	x	x	x	x	x	
Totals	**39**	**33**	**33**	**38**	**39**	**1**

As for the gaps in the competence guides, six of them were not mentioned in the PMCDF guide, namely: Coherence presented by Sołtysik et al. [60]; Critical Thinking, Analytical Thinking and Innovation by Aramo-Immonen et al. [61] and Brill, Bishop and Walker [62]; Information Technology and Curiosity described by Klein and Kelly [58]. In the ICB guide we have a competence gap that is Critical Thinking described in the articles by Aramo-Immonen et al. [61] and Brill, Bishop and Walker [62].

For this type of project, this study found an exclusive competence, that is, a competence not mentioned in the other project types, which is the Coherence competence. Sołtysik et al. [60] and the ICB [9] define competence Coherence as

being able to use a sequence of logical information to convey a message, avoiding contradictions or doubts about a given subject.

4.2.4 Project Type - Remote Teams

Remote Teams projects are characterized by using electronic means and computational resources to support the interaction between professionals. These teams that work remotely need technological resources to carry out the work in a coordinated, specialized, and shared way, ensuring the necessary integration of professionals [33], [64]. In this type of project, 21 competences were identified, 19 of which are common to all the guides: PMCDF, ICB and APM. Table 7 presents the list of the competences found.

Table 7. List of Competences - Project: Remote Teams

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Analytical Thinking	x			x	x	
Autonomy	x	x	x	x	x	
Collaboration	x	x	x	x	x	
Commitment	x	x	x	x	x	
Communication	x	x	x	x	x	
Cooperation	x	x	x	x	x	
Cultural Intelligence	x	x	x	x	x	
Disciplined	x	x	x	x	x	
Experience	x	x	x	x	x	
Information Technology Skills	x			x	x	
Initiative	x	x	x	x	x	
Interpersonal Relationship	x	x	x	x	x	
Leadership	x	x	x	x	x	
Management skills	x	x	x	x	x	
Organizational Skills	x	x	x	x	x	
Professionalism	x	x	x	x	x	
Project Management	x	x	x	x	x	
Reliability	x	x	x	x	x	
Results Orientation	x	x	x	x	x	
Self-control	x	x	x	x	x	
Self-management	x	x	x	x	x	
Totals	**21**	**19**	**19**	**21**	**21**	**0**

In this study, two competence gaps were identified in the PMCDF guide, they are: Information Technology Skills and Analytical Thinking [64]. For Karki and Hadikusumo [65] and Pereira and Freitas [64], Analytical Thinking is the ability to develop an understanding of a situation or problem, dividing it into smaller parts to trace the cause and implications of the situation or problem.

In this type of project, geographic dispersion plays an unexpected and significant role in how the competence of project professionals affects the satisfaction and productivity of team members [66]. Among the competences adhering to this type of project, information technology plays an important role where the project professional needs to know how to use different technologies to adapt to working with remote teams [64].

4.2.5 Project Type – Public Government

Public-type projects implement policies and programs approved by the Government using resources from public management departments for their implementation. In this type of project, there is a wide variety of government stakeholders who have varied and sometimes conflicting interests and expectations. Among those interested there are civil servants and members of local and federal chambers, communities, authorities, and citizens, among others [67], [68]. In this type of project, 80 competences were identified, 56 of which are common to all the guides: PMCDF, ICB and APM. Table 8 presents the list of the competences found.

Table 8. List of Competences - Project: Public Government

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Acceptance	x			x	x	x
Accountability	x		x	x	x	
Adaptability	x	x	x	x	x	
Altruism	x			x		
Analytical Thinking	x			x	x	
Assertiveness	x	x	x	x	x	
Attitude	x	x	x	x	x	
Bidding Management	x	x	x	x	x	
Build Consensus	x	x	x	x	x	
Business Vision	x		x	x	x	
Certification	x			x	x	
Change Management	x			x	x	
Communication	x	x	x	x	x	
Configuration Management	x			x	x	
Conflict Management	x	x	x	x	x	
Conscientiousness	x	x		x	x	
Context Analysis	x	x	x	x	x	
Coordination	x		x	x	x	
Cost Management	x	x	x	x	x	
Courage	x				x	
Cultural Intelligence	x	x	x	x	x	
Customer Focus	x	x	x	x	x	
Decision Making	x		x	x	x	
Delegation	x	x	x	x	x	
Directive Abilities	x	x	x	x	x	
Effectiveness	x	x	x	x	x	
Emotional intelligence	x	x	x	x	x	
Empathy	x	x	x	x	x	
Engagement	x	x	x	x	x	
Enthusiasm	x	x	x	x	x	
Entrepreneurship	x			x	x	
Ethic	x	x	x	x	x	
Experience	x	x	x	x	x	
Financial Management	x			x	x	
Flexibility	x	x	x	x	x	
Foreign language	x	x	x	x	x	
Health management and security	x			x	x	
Honesty	x	x	x	x	x	
Influence	x	x	x	x	x	

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Information Technology Skills	x			x	x	
Initiative	x	x	x	x	x	
Innovation	x			x	x	
Integration Management	x	x	x	x	x	
Interpersonal Relationship	x		x	x	x	
Knowledge Management	x	x	x	x	x	
Leadership	x	x	x	x	x	
Legal Skills	x	x	x	x	x	
Loyalty	x	x	x	x	x	x
Meticulous	x	x	x	x	x	
Monitoring and Control	x	x	x	x	x	
Motivation	x	x	x	x	x	
Negotiation	x	x	x	x	x	
Optimism	x	x	x	x	x	
Organizational Skills	x	x	x	x	x	
People Management	x	x	x	x	x	
Planning Skills	x	x	x	x	x	
Problem Solving	x		x	x	x	
Project Management	x	x	x	x	x	
Quality Management	x	x	x	x	x	
Reliability	x	x	x	x	x	
Resource Management	x	x	x	x	x	
Responsibility	x		x	x	x	
Results Orientation	x	x	x	x	x	
Results Oriented	x	x	x	x	x	
Risk and Uncertainty Management	x	x	x	x	x	
Schedule Management	x	x	x	x	x	
Scope Management	x	x	x	x	x	
Self-awareness	x		x	x	x	
Sensibility	x		x	x	x	
Stakeholder Management	x	x	x	x	x	
Strategic Thinking	x			x	x	
Supplier Management	x	x	x	x	x	
Supply Management	x	x	x	x	x	
Systemic View	x		x	x	x	
Systems Thinking	x		x	x	x	
Team management	x	x	x	x	x	
Technical Abilities	x	x	x	x	x	
Time Management	x	x	x	x	x	
Training Abilities	x	x	x	x	x	
Transparency	x		x	x	x	
Totals	**80**	**55**	**66**	**79**	**79**	**2**

Two competences were identified as unique to this type of project in this study, which are Loyalty [69] and Acceptance [70]. For Gomes et al. [69], the competence of Loyalty refers to the ability of the project professional to honor their commitments to subordinates and the organization, and thus be an effective politician. According to Bashir et al. [70], Acceptance competence refers to the competence of the project professional applied during the project closing phase. Thus, the project professional must be able to manage the acceptance of all documentation and reports delivered by stakeholders.

In this type of project, for the PMCDF competence guide, 14 competences were not mentioned: Acceptance [70]; Altruism [31], [37], [71], [72]; Courage [31]; Change Management [31], [77]; Certification [7], [31], [71], [73], [74];

Conscientiousness [119]; Entrepreneurship [75]-[77]; Configuration Management [70], [77]-[79]; Financial Management [31], [80], [81]; Health management and security [31], [80]-[82]; Information Technology Skills [31]; Analytical Thinking [31], [70]; Strategic Thinking [70], [80]; and Innovation [31].

In the ICB guide, the Courage competence [31] was not mentioned. Finally, in the case of the APM guide, we have the Altruism competence [31], [37], [71], [72] as not mentioned by the guide. For Rezko et al. [31], Innovation competence is evidenced when the project professional uses negotiation and management. Innovation is the result of a process based on a business and technology mindset to encourage the team to create an environment for improving project performance. As a result, this competence helps to increase stakeholder satisfaction with the project [52].

Projects of this category are generally impacted by numerous restrictions imposed by rules, administrative processes, protection systems for contracting, and environments that can include different political adversaries [81]. In this scenario, the competence of Acceptance, pointed out by Bashir et al. [70], contributes to complying with the requirements of these administrative processes. The competence of Loyalty, pointed out by Gomes, Yasin, and Small [69], favors the relationship with stakeholders.

4.2.6 Project Type - Industry 4.0 Project

Industry 4.0 projects are those that use emerging technologies to integrate physical and virtual environments to produce customized products and services. In this way, this competence allows the business ecosystem to function intelligently and autonomously, decentralizing factories and integrating products and services [83], [37]. In this type of project, 43 competences were identified, 32 of which are common to all the guides: PMCDF, ICB and APM. Table 9 presents the list of the competences found.

Table 9. List of Competences - Project: Industry 4.0

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
4RI Digital Skills	x				x	x
Accountability	x	x	x	x	x	
Adaptability	x	x	x	x	x	
Agile Mindset	x				x	
Altruism	x			x		
Analytical Thinking	x			x	x	
Autonomy	x	x	x	x	x	
Collaboration	x	x	x	x	x	
Communication	x	x	x	x	x	
Conflict Management	x	x	x	x	x	
Courage	x				x	
Conscientiousness	x	x	x	x	x	
Creativity	x	x	x	x	x	
Critical Thinking	x				x	
Cultural Intelligence	x	x	x	x	x	
Digital Skills	x				x	
Emotional intelligence	x	x	x	x	x	
Empathy	x	x	x	x	x	
Empowerment	x	x	x	x	x	
Ethic	x	x	x	x	x	
Holistic View	x	x	x	x	x	
Honesty	x	x	x	x	x	
Humility	x	x	x	x	x	
Influence	x	x	x	x	x	
Initiative	x	x	x	x	x	
Interpersonal Relationship	x	x	x	x	x	

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Intuition	x			x	x	
Knowledge Management	x	x	x	x	x	
Leadership	x	x	x	x	x	
Lean Competence	x			x	x	
Negotiation	x	x	x	x	x	
Problem-Solving	x	x	x	x	x	
Processual View	x	x	x	x	x	
Reliability	x	x	x	x	x	
Responsibility	x	x	x	x	x	
Self-awareness	x		x	x	x	
Social Skills	x	x	x	x	x	
Systemic View	x	x	x	x	x	
Team work	x	x	x	x	x	
Technical Abilities	x	x	x	x	x	
Transparency	x	x	x	x	x	
Vision	x	x	x	x	x	
Witty	x			x	x	
Totals	**43**	**32**	**33**	**38**	**42**	**1**

This study identified one unique competence of this type of project: Digital Skills of Industry 4.0 (4RI Digital Skills). For Yahaya and Ebrahim [85], the Digital Skills of Industry 4.0 are related to the possession and application of knowledge of the architecture of the digital tools of Industry 4.0.

Among the competences not mentioned in the guides, we have for the PMCDF guide 11 competence gaps, they are: Altruism [31], [37], [71], [72]; Lean Competence, Courage, Witty, Digital Skills, Digital Skills 4RI, Intuition, Agile Mindset, Analytical Thinking, Critical Thinking [37].

For the ICB guide, we have six unmentioned competences, namely: Courage, Digital Skills, 4RI Digital Skills, Agile Mindset [31], [70] and Critical Thinking [37]. Finally, for the APM guide, the competence gap found is Altruism [31], [37], [71], [72].

It is worth noting that Industry 4.0 implementation projects cause significant impacts on society, mainly in the way we produce and work, which also positively affects organizations. In this scenario, there is a need to develop new competences such as Industry 4.0 Digital Skills [37], [84], [86].

4.2.7 Project Type - Construction Industry

Construction Industry type projects encompass construction, repair, renovation, and maintenance services of infrastructure in the construction business sector [55], [87]. In this type of project, 141 competences were identified, 100 of which are common to all the guides: PMCDF, ICB and APM. Table 10 presents the list of the competences found.

Table 10. List of Competences - Project: Construction Industry

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Adaptability	x	x	x	x	x	
Administrative Skills	x	x	x	x	x	
Agile Mindset	x				x	
Altruism	x			x		
Ambition	x	x	x	x	x	
Analytical Thinking	x			x	x	

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Assertiveness	x	x	x	x	x	
Attitude	x	x	x	x	x	
Auto Motivation	x	x	x	x	x	
Bidding Management	x	x	x	x	x	
Build Consensus	x	x	x	x	x	
Business Skills	x	x	x	x	x	
Business Vision	x	x	x	x	x	
Certification	x			x	x	
Change Management	x			x	x	
Charisma	x			x	x	x
Claims management	x			x	x	
Cognitive Skills	x		x		x	
Coaching	x			x	x	
Collaboration	x	x	x	x	x	
Commitment	x	x	x	x	x	
Communication	x	x	x	x	x	
Configuration Management	x			x	x	
Conflict Management	x	x	x	x	x	
Construction Management	x			x	x	
Context Analysis	x		x	x	x	
Continuous Improvement	x			x	x	
Contract Management	x	x	x	x	x	
Cooperation	x	x	x	x	x	
Coordination	x	x	x	x	x	
Cost Management	x	x	x	x	x	
Courage	x				x	x
Creativity	x	x	x	x	x	
Critical Analysis	x	x	x	x	x	
Critical Thinking	x			x	x	
Cultural Intelligence	x	x	x	x	x	
Curiosity	x			x	x	
Customer Focus	x	x	x	x	x	
Decision Making	x	x	x	x	x	
Dedication	x	x	x	x	x	
Delegation	x	x	x	x	x	
Developing followers	x	x	x	x	x	
Digital Skills	x				x	
Disciplined	x	x	x	x	x	
Effectiveness	x	x	x	x	x	
Emotional intelligence	x	x	x	x	x	
Empathy	x	x	x	x	x	
Empowerment	x	x	x	x	x	
Encouragement	x	x	x	x	x	
Engagement	x	x	x	x	x	
Enthusiasm	x	x	x	x	x	
Entrepreneurship	x			x	x	
Environmental Awareness	x			x	x	
Environmental Legislation and Administration	x			x	x	
Ethic	x	x	x	x	x	
Evaluative Competence	x				x	x
Experience	x	x	x	x	x	
Facilitation	x	x	x	x	x	x
Feedback Skills	x	x	x	x	x	
Flexibility	x	x	x	x	x	

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Focus	x	x	x	x	x	
Foreign language	x	x	x	x	x	
Health management and security	x			x	x	
Holistic View	x	x	x	x	x	
Honesty	x	x	x	x	x	
Influence	x	x	x	x	x	
Information Technology Skills	x			x	x	
Initiative	x	x	x	x	x	
Innovation	x	x		x	x	
Inspiration	x		x	x	x	x
Integration Management	x	x	x	x	x	
Intellectual Skills	x	x	x	x	x	
Interpersonal Relationship	x	x	x	x	x	
Interpersonal Skills	x	x	x	x	x	
Intuition	x			x	x	
Inventory Management	x				x	x
Knowledge Management	x	x	x	x	x	
Leadership	x	x	x	x	x	
Legal Skills	x	x	x	x	x	
Local Skills	x		x		x	
Logical Reasoning	x	x	x	x	x	x
Management of Roles and Responsibilities	x		x	x	x	
Management skills	x		x	x	x	
Marketing Skills	x			x	x	
Mentoring	x	x	x	x	x	
Merge and Acquisition	x	x	x	x	x	
Meticulous	x	x	x	x	x	
Monitoring and Control	x	x	x	x	x	
Motivation	x	x	x	x	x	
Multiple Project Management	x				x	
Negotiation	x	x	x	x	x	
Open to New Experiences	x			x	x	
Operations Research Skills	x				x	x
Optimism	x	x	x	x	x	
Organizational Skills	x	x	x	x	x	
Patience	x	x	x	x	x	x
People Management	x		x	x	x	
Persistence	x	x	x	x	x	
Persuasion	x		x	x	x	
Planning Skills	x	x	x	x	x	
Proactivity	x	x	x	x	x	
Problem Management	x	x	x	x	x	
Problem Solving	x	x	x	x	x	
Professionalism	x	x	x	x	x	
Project Management	x	x	x	x	x	
Project Management Skills	x	x	x	x	x	
Quality Management	x	x	x	x	x	
Recruitment Skills	x			x	x	x
Relational Competence	x	x	x	x	x	
Reliability	x	x	x	x	x	
Resilience	x	x	x	x	x	
Resource Management	x	x	x	x	x	
Responsibility	x	x	x	x	x	
Results Orientation	x	x	x	x	x	

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Results Oriented	x	x	x	x	x	
Roles and Responsibility Management	x	x	x	x	x	
Risk and Uncertainty Management	x	x	x	x	x	
Schedule Management	x	x	x	x	x	
Scope Management	x	x	x	x	x	
Self-awareness	x		x	x	x	
Self-confidence	x	x	x	x	x	
Self-control	x		x	x	x	
Self-management	x	x	x	x	x	
Self-taught	x			x	x	
Sensibility	x	x	x	x	x	
Social Skills	x	x	x	x	x	
Stakeholder Management	x	x	x	x	x	
Strategic Planning	x			x	x	x
Strategic Thinking	x			x	x	
Structured Thinking	x	x	x	x	x	x
Supplier Management	x	x	x	x	x	
Supply Chain Management	x	x	x	x	x	
Supply Management	x	x	x	x	x	
Systemic View	x	x	x	x	x	
Systems Thinking	x	x	x	x	x	
Team management	x	x	x	x	x	
Team work	x	x	x	x	x	
Technical Abilities	x	x	x	x	x	
Time Management	x	x	x	x	x	
Vision	x	x	x	x	x	
Vision and Imagination	x	x	x	x	x	
Totals	**141**	**100**	**109**	**132**	**140**	**12**

The study identified 12 unique competences for the type of Construction project, they are: Evaluative Competence [76], Logical Reasoning, Charisma, and Patience [12], Facilitation and Courage [88], Inventory Management, Operations Research and Recruitment [77], Inspiration [89], Structured Thinking [90] and Strategic Planning [91].

The following competences were not mentioned for the PMCDF guide: Open to New Experiences [12], [35], [77], [92]; Altruism [31], [37], [70], [71]; Charisma [70], Change Management [31], [77]; Certification [31], [71], [73]; Coaching [12], [55], [92]-[94]; Evaluative Competence [76], Environmental Awareness and Inventory Management [77], [92], [95], [96]; Courage [31], [70]; Curiosity [12], [55] [93]; Entrepreneurship [75]-[77]; Configuration Management [70], [77]; Construction Management [55], [77]; Health management and if security [12], [71], [77], [97], [98]; Claims management [98]; Marketing Skills, Recruitment Skills and Operations Research Skills [76]; Information Technology Skills [70], [71], [91],[92],[95],[96]; Digital Skills [31], [70]; Innovation [16], [31], [71], [92], [96]; Intuition [88], [100]-[101]; Environmental Legislation and Administration [12], [77]; Continuous Improvement [49], [77], [92], [94]; Agile Mindset [31], [70]; Multiple Project Management [38]; Analytical Thinking [16], [32], [55], [65], [70]; Critical Thinking [55], [94], [104]; Strategic Thinking [70], [71], [77], [81], [90]; Self-Taught [88], [94]; [Strategic Planning [91].

For the ICB guide, the following competences were not mentioned: Cognitive Skills [37], [71]; Evaluative Competence [76]; Courage [70], [31]; Inventory Management and Operations Research Skills [76]; Digital Skills and Agile Mindset [70], [31]; Multiple Project Management [38]; Local Skills [100]. Finally, for the APM guide, the following competences were not mentioned: Altruism [31], [37], [71], [72].

Among the gaps in competences pointed out, Lampel [76] argues that Evaluative competence is intended to find a balance regarding human beings and systems during the execution of the project, not allowing the decision-making

process to always be driven by data. The greater number of competences found for this type of project may be related to the number of articles belonging to this research corpus, which corresponds to 32% of the total articles.

4.2.8 Project Type - Multiple Projects

Multiple Projects are those where several projects with independent objectives and deliverables are executed at the same time, in parallel and sharing the same team and the same management system [38], [103], [104]. In this type of project, 29 competences were identified, 23 of which are common to all the guides: PMCDF, ICB and APM. Table 11 presents the list of the competences found.

Table 11. List of Competences - Project: Multiple Projects

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Ambition	x	x	x	x	x	
Analytical Thinking	x			x	x	
Autonomy	x	x	x	x	x	
Communication	x	x	x	x	x	
Conflict Management	x	x	x	x	x	
Customer Focus	x	x	x	x	x	
Disciplined	x	x	x	x	x	
Emotional intelligence	x	x	x	x	x	
Financial Management	x			x	x	
Flexibility	x	x	x	x	x	
Information Technology Skills	x			x	x	
Integrative Thinking	x	x	x	x	x	
Interpersonal Relationship	x	x	x	x	x	
Leadership	x	x	x	x	x	
Merge and Acquisition	x				x	
Monitoring and Control	x	x	x	x	x	
Multitasking	x			x	x	
Multiple Project Management	x			x	x	
Negotiation	x	x	x	x	x	
Proactivity	x	x	x	x	x	
Problem Solving	x	x	x	x	x	
Project Management	x		x	x	x	
Resource Management	x	x	x	x	x	
Responsibility	x	x	x	x	x	
Risk and Uncertainty Management	x	x	x	x	x	
Schedule Management	x	x	x	x	x	
Self-control	x	x	x	x	x	
Strategic Thinking	x			x	x	
Team management	x	x	x	x	x	
Technical Abilities	x	x	x	x	x	
Totals	**29**	**21**	**22**	**28**	**29**	**0**

As for competences gaps, six of them were not identified in the PMDCF guide: Strategic Thinking [70], [71], [77], [81], [90], Analytical Thinking [64], Multitasking [78], Information Technology Skills [31], Financial Management [31], [80], [81] and Multiple Project Management [38], and Merge and Acquisition [97]. In the ICB, a competence gap is also Merge and Acquisition [97]. According to Patanakul and Milosevic [38], the competence of Multiple Project Management means coordinating one's own work with that of other members of a project or projects in a multi-project scenario.

In this study, only three articles were found, corresponding to 1% of the research corpus. This situation is described by Patanakul and Milosevic [33], who state that studies on Multiple Projects are rare. The same occurs for the Multiple Project Management competence, which is also little studied.

4.2.9 Project Type - Research and Development

Research and Development projects are conducted and financed by public and private research centers using models of collaboration processes in these centers [105], [106]. In this type of project, five competences were identified, all common to the guides: PMCDF, ICB and APM. Table 12 presents the list of the competences found.

Table 12. List of Competences - Project: Research and Development

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Communication	x	x	x	x	x	
Creativity	x	x	x	x	x	
Flexibility	x	x	x	x	x	
Problem-Solving	x	x	x	x	x	
Technical Abilities	x	x	x	x	x	
Totals	**5**	**5**	**5**	**5**	**5**	**0**

According to Moradi et al. [35] and Vraniak et al. [107], Problem-Solving competence is the ability to recognize the problem and manage activities focused on its resolution ethically. For Mumford [108] and Lamas et al. [109], Creativity competence is defined as the interaction of skills, methods, and processes to produce a new and useful idea within a social context.

Projects of this type are financed by public or private organizations, which are subject to strict schedules imposed by those granting the funding, setting rigid and inflexible deadlines [105]. Given this situation, the sponsoring institution may require creativity from project professionals to adapt the project and activities to this reality.

4.2.10 Project Type – Services

Service-type projects are those that provide industry-specific service standards, capabilities, and experience. Service projects are carried out by professionals in the service sector, for example, in financial and insurance services, training/coaching services and information technology services [110], [111]. In this type of project, 64 competences were identified, 56 of which are common to all the guides: PMCDF, ICB and APM. Table 13 presents the list of the competences found.

Table 13. List of Competences - Project: Services

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Adaptability	x	x	x	x	x	
Administrative Skills	x	x	x	x	x	
Analytical Thinking	x			x	x	
Assertiveness	x	x	x	x	x	
Autonomy	x	x	x	x	x	
Coaching	x			x	x	
Collaboration	x	x	x	x	x	
Communication	x	x	x	x	x	
Configuration Management	x			x	x	
Conflict Management	x	x	x	x	x	
Context Analysis	x	x	x	x	x	

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Cooperation	x	x	x	x	x	
Coordination	x	x	x	x	x	
Creativity	x	x	x	x	x	
Critical Analysis	x	x	x	x	x	
Critical Thinking	x				x	
Delegation	x	x	x	x	x	
Developing followers	x	x	x	x	x	
Effectiveness	x	x	x	x	x	
Emotional intelligence	x	x	x	x	x	
Empathy	x	x	x	x	x	
Engagement	x	x	x	x	x	
Flexibility	x	x	x	x	x	
Foreign language	x	x	x	x	x	
Influence	x	x	x	x	x	
Information Technology Skills	x			x	x	
Initiative	x	x	x	x	x	
Integration Management	x	x	x	x	x	
Integrative Thinking	x	x	x	x	x	
Interpersonal Relationship	x	x	x	x	x	
Knowledge Management	x	x	x	x	x	
Leadership	x	x	x	x	x	
Legal Skills	x	x	x	x	x	
Manage Ambiguity	x			x	x	
Management of Roles and Responsibilities	x	x	x	x	x	
Meticulous	x	x	x	x	x	
Monitoring and Control	x	x	x	x	x	
Motivation	x	x	x	x	x	
Multitasking	x			x	x	
Negotiation	x	x	x	x	x	
Optimism	x	x	x	x	x	
Organizational Skills	x	x	x	x	x	
Persuasion	x	x	x	x	x	
Proactivity	x	x	x	x	x	
Problem Solving	x	x	x	x	x	
Project Management	x	x	x	x	x	
Reflection	x	x	x	x	x	
Reliability	x	x	x	x	x	
Resilience	x	x	x	x	x	
Resource Management	x	x	x	x	x	
Respect	x	x	x	x	x	
Responsibility	x	x	x	x	x	
Results Orientation	x	x	x	x	x	
Risk and Uncertainty Management	x	x	x	x	x	
Schedule Management	x	x	x	x	x	
Self-awareness	x	x	x	x	x	
Sensibility	x	x	x	x	x	
Social Skills	x	x	x	x	x	
Supplier Management	x	x	x	x	x	
Systems Thinking	x	x	x	x	x	
Team management	x	x	x	x	x	
Team work	x	x	x	x	x	
Technical Abilities	x	x	x	x	x	
Time Management	x	x	x	x	x	
Totals	**64**	**57**	**57**	**63**	**64**	**0**

Among the competences that belong to this type of project it can be highlighted Reliability. Gray and Ulbrich [56] define Reliability competence as inspiring trust through dialogue. Moradi et al. [14] add to it the fulfillment of promises to complete the agreed work. Among the competences not mentioned in the PMDCF guide are: Coaching [112]; Configuration Management [70], [77]; Manage Ambiguity [56]; Information Technology Skills [70], [71], [91], [92], [95], [96]; Multitasking [78]; Analytical Thinking [16], [32], [55], [65], [70] and Critical Thinking [55], [94], [102]. In the IPMA guide, it is not mentioned the competence Critical Thinking [55], [94], [102].

One of the competence gaps found is Multitasking. This competence, according to Plaza-Lara [78], is the ability not only to manage different projects, but also to make reports, manage resources, and supervise a team, among other activities. While Manage Ambiguity and Multitasking competences have been identified in other types of projects, for service projects, they are more relevant for project professionals to be successful [56], [78].

4.2.11 Project Type – Sustainability

Sustainability projects are related to those that promote the development of activities that are harmoniously integrated with the planet's ecosystem [113], [114]. In this type of project, 37 competences were identified, 27 of which are common to all the guides: PMCDF, ICB and APM. Table 14 presents the list of the competences found.

Table 14. List of Competences - Project: Sustainability

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Adaptability	x	x	x	x	x	
Analytical Thinking	x			x	x	
Change Management	x			x	x	
Claims management	x			x	x	
Communication	x	x	x	x	x	
Conflict Management	x	x	x	x	x	
Cost Management	x	x	x	x	x	
Creativity	x	x	x	x	x	
Critical Analysis	x	x	x	x	x	
Critical Thinking	x				x	
Curiosity	x			x	x	
Decision Making	x	x	x	x	x	
Delegation	x	x	x	x	x	
Ethic	x	x	x	x	x	
Health Safety Management	x			x	x	
Information Technology Skills	x			x	x	
Initiative	x	x	x	x	x	
Innovation	x			x	x	
Leadership	x	x	x	x	x	
Management skills	x	x	x	x	x	
Meticulous	x	x	x	x	x	
Monitoring and Control	x	x	x	x	x	
Negotiation	x	x	x	x	x	
Open to New Experiences	x			x	x	
Organizational Skills	x	x	x	x	x	
People Management	x	x	x	x	x	
Problem-Solving	x	x	x	x	x	
Professionalism	x	x	x	x	x	
Resilience	x	x	x	x	x	
Resource Management	x	x	x	x	x	
Risk and Uncertainty Management	x	x	x	x	x	
Schedule Management	x	x	x	x	x	
Self-taught	x			x	x	

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Stakeholder Management	x	x	x	x	x	
Supply Management	x	x	x	x	x	
Team work	x	x	x	x	x	
Vision and Imagination	x	x	x	x	x	
Totals	**37**	**27**	**27**	**36**	**37**	**0**

The study found ten competences gaps in the PMCDF guide: Critical Thinking, Curiosity and Open to New Experiences [115]; Analytical Thinking [115], [114]; Self-Taught [88], [94]; Innovation [116]; Information Technology Skills [116]; Change Management [31], [77]; Claims Management, Health and Safety Management [114]. In the ICB, the competence gap found is Critical Thinking [115].

Among the competences found can be highlighted Health and Safety Management, which, according to Hwang and Ng [114], is related to knowing government policies and regulations designed to protect human health and the environment. Furthermore, Isik et al. [98] emphasize the need to apply and train the team in this competence. Although the competence of Health and Safety Management has been identified in projects of the Construction type, for Sustainability projects, greater importance is inferred [114].

For this type of project, the relevance of this competence is given by the global concerns related to climate change and sustainable development, which has stimulated the need for project professionals with this competence due to their important role in the execution and delivery of projects [114], even complying with environmental and safety standards [65].

4.2.12 Project Type - Information Technology

Information technology projects are those that use resources, team management processes and technology components to achieve the objectives of the organization's information technology strategy plan [121], [118]. In this type of category, 64 competences were identified, 52 of which are common to the PMCDF, ICB and APM guides, presented in Table 15.

Table 15. List of Competences - Project: Information Technology

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Adaptability	x	x	x	x	x	
Analytical Thinking	x			x	x	
Assertiveness	x	x	x	x	x	
Authority	x	x	x	x	x	
Build Consensus	x	x	x	x	x	
Business Skills	x	x	x	x	x	
Certification	x			x	x	
Change Management	x			x	x	
Communication	x	x	x	x	x	
Conflict Management	x	x	x	x	x	
Conscientiousness	x			x	x	
Cooperation	x	x	x	x	x	
Coordination	x	x	x	x	x	
Curiosity	x			x	x	
Customer Focus	x	x	x	x	x	
Decision Making	x	x	x	x	x	
Developing followers	x	x	x	x	x	
Directive Abilities	x	x	x	x	x	
Effectiveness	x	x	x	x	x	

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Emotional intelligence	x	x	x	x	x	
Empathy	x	x	x	x	x	
Ethic	x	x	x	x	x	
Experience	x	x	x	x	x	
Flexibility	x	x	x	x	x	
Holistic View	x	x	x	x	x	
Honesty	x	x	x	x	x	
Human Resource Skills	x	x	x	x	x	
Influence	x	x	x	x	x	
Information Technology Skills	x			x	x	
Innovation	x			x	x	
Intellectual Skills	x	x	x	x	x	
Interpersonal Relationship	x	x	x	x	x	
Leadership	x	x	x	x	x	
Manage Ambiguity	x			x	x	
Management skills	x	x	x	x	x	
Marketing Skills	x			x	x	
Monitoring and Control	x	x	x	x	x	
Motivation	x	x	x	x	x	
Multitasking	x			x	x	
Negotiation	x	x	x	x	x	
Open to New Experiences	x			x	x	
Optimism	x	x	x	x	x	
Persistence	x	x	x	x	x	
Persuasion	x	x	x	x	x	
Planning Skills	x	x	x	x	x	
Problem Management	x	x	x	x	x	
Problem Solving	x	x	x	x	x	
Project Management Skills	x	x	x	x	x	
Reliability	x	x	x	x	x	
Resilience	x	x	x	x	x	
Responsibility	x	x	x	x	x	
Results Orientation	x	x	x	x	x	
Results Oriented	x	x	x	x	x	
Risk and Uncertainty Management	x	x	x	x	x	
Schedule Management	x	x	x	x	x	
Self-taught	x			x	x	
Stakeholder Management	x	x	x	x	x	
Supplier Management	x	x	x	x	x	
Team management	x	x	x	x	x	
Team work	x	x	x	x	x	
Technical Abilities	x	x	x	x	x	
Training Abilities	x	x	x	x	x	
Transparency	x	x	x	x	x	
Vision	x	x	x	x	x	
Totals	**64**	**52**	**52**	**64**	**64**	**0**

The competence gaps found in the PMCDF guide are: Open to New Experiences [77], [12], [92], [35]; Self-taught [42]; Certification [7], [31], [71], [74]; Conscientiousness [18]; Curiosity [12], [93], [55]; Change Management [118]; Manage Ambiguity [56]; Marketing Skills [76]; Information Technology Skills [95], [96], [70], [71], [92], [91]; Innovation [51], [52]; Multitasking [78]; Analytical Thinking [16], [70], [32], [65], [55].

For Strang and Strang [119], competence Conscientiousness is the ability to operate projects responsibly, oriented towards implementation with discipline and diligence. Podgórska and Pichlak [18] add that it is necessary to

demonstrate a clear commitment to the course of action and, even when confronted, to encourage others to support the chosen direction. Another competence gap is Change Management, which for Brière et al. [99], is associated with the ability to consider the importance of change strategies in project implementation.

For this type of project, executives value competences such as Leadership, Communication, Managing Ambiguity and Change Management, as opposed to other competences such as Experience, Work History, Education and Technical Knowledge [117].

4.2.13 Project Type – Telecommunications

Telecommunications projects are those that develop products and services for the telecommunications segment [124], [36]. In this type of category, four competences were identified, all included in the PMCDF, ICB and APM guides, presented in Table 16.

Table 16. List of Competences - Project: Telecommunications

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Administrative Skills	x	x	x	x	x	
Leadership	x	x	x	x	x	
Project Management	x	x	x	x	x	
Technical Abilities	x	x	x	x	x	
Totals	**4**	**4**	**4**	**4**	**4**	**0**

In this category, there are four competences identified by Kosaroglu and Hunt [120]: Leadership, Technical Abilities, Administrative Skills and Project Management. Also, according to these authors, Leadership refers to skills that underlie behaviors to affect positively in favor of project management. Administrative Skills are related to the process of visualizing and understanding the organization's areas, culture, and formal and informal processes, in order to use methods and tools in an integrated way to optimize results [91], [120].

However, for this type of project, only two articles were identified, and no gaps were identified. Regarding telecommunication projects, it is important to analyze this segment from a technological point of view, where disruptive technologies can have a great effect on the life cycle of projects in terms of the ability to understand the problems and changes caused by them. It is assumed that to remain aligned with the changing needs of the business environment, organizations need to continually assess their internal business strategies for ongoing effectiveness, thus ensuring that current competences do not become obsolete in the future [36].

4.2.14 Project Type - Third Sector

Third Sector projects are non-governmental projects promoted by civil society organizations [100], [121]. In this type of category, 13 competences were identified, 7 of which are common to PMCDF, ICB and APM guides, presented in Table 17.

One competence was identified as unique to this project type: Ability Range [99]. The Ability Range competence, according to Brière et al. [99], addresses a wide variety of competences that a project professional must have to perform various tasks.

Table 17. List of Competences - Project: Third Sector

Competence	Research Literature	Common to Guides	PMCDF	ICB	APM	Exclusive
Ability Range	x			x		x
Adaptability	x	x	x	x	x	
Change Management	x			x	x	
Communication	x	x	x	x	x	
Curiosity	x			x	x	
Empathy	x	x	x	x	x	
Ethic	x	x	x	x	x	
Innovation	x			x	x	
Interpersonal Relationship	x	x	x	x	x	
Local Skills	x				x	
Management skills	x	x	x	x	x	
Passion	x			x	x	
Systems Thinking	x	x	x	x	x	
Totals	**13**	**7**	**7**	**12**	**12**	**1**

Among the competences not mentioned in the PMCDF guide are: Ability Range [99], Curiosity [12], [93], [55]; Change Management [122]; Local Skills [100]; Innovation [96], [16], [71], [31], [92]; and Passion [121]. In the ICB guide, the competence gap found is that of Local Skills [100]. Finally, for the APM guide, the skills gap is Ability Range [99].

One of the identified competence gaps is Local Skills. According to Brière et al. [99], this competence addresses the ability to use local know-how to ensure that the work performed for the project meets the reality of the environment in which the project is inserted. In this type of project, the execution requires competent and qualified professional organizations, with the ability to work in different cultures and sometimes in difficult conditions and complex environments [100],[121]. Another competence gap is Passion competence, which, for Charleston et al. [121], means the capacity to learn about cross-cultural interactions and other challenges passionately.

5. Discussion

Based on the research corpus and categorizing the competences of project professionals by type of project, it is possible to infer that the competence guides addressed in this study have gaps when dealing with the specifics of each type of project.

From the research corpus, 173 competences were identified. The competences were then compared with the PMCDF, ICB and APM guides. Table 18 shows the 14 types of projects identified in this study and the number of competences that are not mentioned in the PMCDF, IPMA and APM guides. For example, for the Complex project type, there are seven missing competences in the PMCDF. Also, for this type of project, in the ICB and APM guides, there are competences not mentioned in the respective guides.

The number of competences not mentioned by guides in the case of construction projects may be related to the high number of studies related to this type of project (32% of the articles). However, it is not possible to make the same analogy for other types of projects. Analyzing the information in Table 18, it can be concluded that within the scope of this study, the PMCDF competence guide presents the largest amount of non-covered competences, which is understandable since PMCDF is described as a guide to competence with a generic structure [10]. Yet, PMCDF also assumes that individual competences are transferable across industries and organizations [10]. However, our study presents competences not covered by the PMCDF and a set of specific competences by type of project.

The PMCDF, ICB, and APM competence guides do not have a solid research base, as pointed out by Chipulu et al. [7] and Crawford [5]. This criticism does not detract from the guides; it only reflects the accuracy in presenting models that tend to be prescriptive and non-specific, not addressing the specific competences required for each type of project [28].

Table 18. Types of projects and competences not mentioned in the guides

Summary - Project Typology	Research Literature	Common to Guides	Not Mentioned			Exclusive
			PMCDF	ICB	APM	
Complex	38	30	7	1	1	2
Construction Industry	141	100	32	9	1	12
Education	39	33	6	1	0	1
Industry 4.0	43	32	10	5	1	1
Information Technology	64	52	12	0	0	0
Multiple Projects	29	21	7	1	0	0
Public Government	80	66	15	1	1	2
Remote Teams	21	19	2	0	0	0
Research Development	5	5	0	0	0	0
Services	64	57	7	1	0	0
Software Development	51	44	7	2	0	0
Sustainability	37	10	10	1	0	0
Telecommunications	4	4	0	0	0	0
Third Sector	13	7	6	1	1	1

Still concerning the types of projects, over time (Table 1), the emergence or importance of certain competences can be seen. These competences may arise as a result of technological evolution, as pointed out by Whitmore et al. [84] and Marnewick and Marnewick [37], such as Industry 4.0 Digital Skills. Along the same lines, the increase in the complexity of projects due to globalization and economic volatility [1] requires competences such as Managing Ambiguity [56], Phronesis [39], and Project Management Routine [42].

Furthermore, for almost all types of projects analyzed, there are specific competences, and in some cases, competences are mentioned for only one type of project. Among the 14 types of projects studied, several competences were not mentioned in at least one of the guides, which may indicate the need to update these. For specific competences associated with some types of projects, five types of projects were identified: Complex, Public Government, Industry 4.0, Construction and Third Sector. In this sense, corroborating what was pointed out by Ahsan et al. [28], Morris et al. [29], Cicmil et al. [30] and Rezk et al. [31], we claim that the type of project influences the competences of the project professional. Thus, we can infer that different types of projects require project professionals with specific competences [124], [14], [34].

Regarding the type of software development projects, all the guides studied consider that the competences needed by design professionals are the same, regardless of the approach used. However, given the main differences between the Traditional and Agile project management approaches, the perceived importance of these competences may vary according to the project approach used [54]. In this sense, companies migrating from the traditional to agile project approach can do so in a more targeted way [50].

Finally, for Education-type projects, it is necessary to carry out a systematic study of the competences of project managers, taking into account the expectations of the students, the stakeholders themselves - that is, project managers - as well as specialists [60]. Thus, educational institutions could explore ways to reinforce their students' preparation to manage projects, emphasizing the preparation and construction of these competences through practical projects during their academic preparation [125].

Table 19 lists all the competences that resulted from this systematic literature review. The table presents the name of the competence and the project type where the competence has been found. The column total presents how many times the competence has been found, regardless of the type of the project.

Table 19. List of Competences x Types of Project / Guides

Competence Name x Types of project / Guides	Industry 4.0	Construction	Research and Development	Education	Third Sector	Multiple Projects	Telecommunications	Public Government	Remote Teams	Software Development	Information Technology	Sustainability	Services	Complex	**PMCDF**	**ICB**	**APM**	**Total**
4RI Digital Skills	x																x	1
Ability Range					x											x		1
Acceptance								x								x	x	1
Accountability	x							x							x	x	x	2
Adaptability	x	x		x	x			x		x	x	x	x	x	x	x	x	10
Administrative Skills		x					x						x		x	x	x	3
Agile Mindset	x	x								x							x	3
Altruism	x	x						x								x		3
Ambition		x				x									x	x	x	2
Analytical Thinking	x	x		x		x		x	x	x	x	x	x	x		x	x	11
Assertiveness		x						x			x		x		x	x	x	4
Attitude		x		x				x		x					x	x	x	4
Authority											x				x	x	x	1
Auto Motivation		x													x	x	x	1
Autonomy	x					x			x				x		x	x	x	4
Bidding Management		x						x							x	x	x	2
Build Consensus		x						x			x				x	x	x	3
Business Skills		x								x	x				x	x	x	3
Business Vision		x						x							x	x	x	2
Certification		x						x			x				x	x	x	3
Change Management		x			x			x			x	x		x		x	x	6
Charisma		x														x	x	1
Claims Management		x										x				x	x	2
Coaching		x											x			x	x	2
Cognitive Skills		x													x		x	1
Coherence				x												x	x	1
Collaboration	x	x		x					x	x			x		x	x	x	6
Commitment		x		x					x						x	x	x	3
Communication	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	13
Configuration Management		x						x					x			x	x	3
Conflict Management	x	x		x		x		x		x	x	x	x		x	x	x	9
Conscientiousness	x							x			x			x		x	x	4
Construction Management		x														x	x	1

Competence Name x Types of project / Guides	Industry 4.0	Construction	Research and Development	Education	Third Sector	Multiple Projects	Telecommunications	Public Government	Remote Teams	Software Development	Information Technology	Sustainability	Services	Complex	**PMCDF**	**ICB**	**APM**	**Total**
Context Analysis		x						x		x			x		x	x	x	4
Continuous Improvement		x								x						x	x	2
Contract Management		x												x	x	x	x	2
Cooperation		x							x	x	x		x	x	x	x	x	6
Coordination		x						x			x		x		x	x	x	4
Cost Management		x						x		x		x		x	x	x	x	5
Courage	x	x						x									x	3
Creativity		x		x								x	x		x	x	x	4
Critical Analysis		x		x						x		x	x		x	x	x	5
Critical Thinking	x	x		x						x		x	x				x	6
Cultural Intelligence	x	x		x				x	x	x					x	x	x	6
Curiosity		x		x	x						x	x		x		x	x	6
Customer Focus		x				x		x		x	x				x	x	x	5
Decision Making		x						x		x	x	x		x	x	x	x	6
Dedication		x												x	x	x	x	2
Delegation		x						x				x	x		x	x	x	4
Developing followers		x									x		x					3
Digital Skills	x	x															x	2
Directive Abilities								x			x				x	x	x	2
Disciplined		x		x		x			x						x	x	x	4
Effectiveness		x		x				x		x	x		x		x	x	x	6
Emotional Intelligence	x	x		x		x		x		x	x		x	x	x	x	x	9
Empathy	x	x		x	x			x			x		x	x	x	x	x	8
Empowerment	x	x								x				x	x	x	x	4
Encouragement		x													x	x	x	1
Engagement		x		x				x		x			x		x	x	x	5
Enthusiasm		x						x							x	x	x	2
Entrepreneurship		x						x								x	x	2
Environmental Awareness		x														x	x	1
Environmental Legislation and Administration	x															x	x	1
Ethic	x	x			x			x		x	x	x			x	x	x	7
Evaluative Competence		x															x	1
Experience		x						x	x	x	x				x	x	x	5

Competence Name x Types of project / Guides	Industry 4.0	Construction	Research and Development	Education	Third Sector	Multiple Projects	Telecommunications	Public Government	Remote Teams	Software Development	Information Technology	Sustainability	Services	Complex	**PMCDF**	**ICB**	**APM**	**Total**
Facilitation		x													x	x	x	1
Feedback Skills		x								x					x	x	x	2
Financial Management						x		x								x	x	2
Flexibility		x	x			x		x		x	x		x	x	x	x	x	8
Focus		x		x											x	x	x	2
Foreign language		x		x				x		x			x		x	x	x	5
Health management and security		x						x								x	x	2
Health Safety Management												x				x	x	1
Holistic View	x	x									x				x	x	x	3
Honesty	x	x						x			x				x	x	x	4
Human Resource Skills											x				x	x	x	1
Humility	x														x	x	x	1
Influence	x	x		x				x		x	x		x		x	x	x	7
Information Technology Skills		x	x	x		x		x	x	x	x	x	x			x	x	10
Initiative	x	x		x				x	x			x	x		x	x	x	7
Innovation		x		x	x			x		x	x	x				x	x	7
Inspiration		x													x	x	x	1
Integration Management		x						x					x		x	x	x	3
Integrative Thinking						x							x		x	x	x	2
Intellectual Skills		x									x				x	x	x	2
Interpersonal Relationship	x	x		x	x	x		x	x	x	x		x		x	x	x	10
Interpersonal Skills		x								x					x	x	x	2
Intuition	x	x														x	x	2
Inventory Management		x															x	1
Knowledge Management	x	x						x		x			x		x	x	x	5
Leadership	x	x		x		x	x	x	x	x	x	x	x		x	x	x	11
Lean Competence	x															x	x	1
Legal Skills		x						x					x		x	x	x	3
Local Skills		x			x										x		x	2
Logical Reasoning		x													x	x	x	1
Loyalty								x							x	x	x	1
Manage Ambiguity											x		x			x	x	2
Management of Roles and Responsibilities		x											x		x	x	x	2

Competence Name x Types of project / Guides	Industry 4.0	Construction	Research and Development	Education	Third Sector	Multiple Projects	Telecommunications	Public Government	Remote Teams	Software Development	Information Technology	Sustainability	Services	Complex	**PMCDF**	**ICB**	**APM**	**Total**
Management skills		x			x				x		x	x			x	x	x	5
Marketing Skills		x									x					x	x	2
Mentoring		x								x					x	x	x	2
Merge and Acquisition		x													x	x	x	1
Meticulous		x						x				x	x		x	x	x	4
Monitoring and Control		x				x		x			x	x	x		x	x	x	6
Motivation		x						x			x		x	x	x	x	x	5
Multiple Project Management		x				x											x	2
Multitask						x					x		x			x	x	3
Negotiation	x	x				x		x		x	x	x	x	x	x	x	x	9
Open to New Experiences		x									x	x				x	x	3
Operations Research Skills		x															x	1
Optimism		x		x				x			x		x		x	x	x	5
Organizational Skills		x						x	x	x		x	x		x	x	x	6
Passion					x											x	x	1
Patience		x													x	x	x	1
People Management		x						x		x		x		x	x	x	x	5
Persistence		x									x				x	x	x	2
Persuasion		x								x	x		x		x	x	x	4
Phronesis														x	x			1
Planning Skills		x						x			x				x	x	x	3
Proactivity		x				x				x			x	x	x	x	x	5
Problem Management		x									x				x	x	x	2
Problem Solving	x	x	x	x		x		x		x	x	x	x		x	x	x	10
Processual View	x														x	x	x	1
Professionalism		x							x			x			x	x	x	3
Project Management		x		x		x	x	x	x	x			x		x	x	x	8
Project Management Skills		x									x				x	x	x	2
Purchasing Management														x	x	x	x	1
Quality Management		x						x						x	x	x	x	3
Recruitment Skills		x														x	x	1
Reflection										x			x		x	x	x	2
Relational Competence		x													x	x	x	1
Reliability	x	x		x				x	x	x	x		x		x	x	x	8

Competence Name x Types of project / Guides	Industry 4.0	Construction	Research and Development	Education	Third Sector	Multiple Projects	Telecommunications	Public Government	Remote Teams	Software Development	Information Technology	Sustainability	Services	Complex	**PMCDF**	**ICB**	**APM**	**Total**
Resilience	x	x		x							x	x	x		x	x	x	6
Resource Management		x				x		x				x	x	x	x	x	x	6
Respect													x		x	x	x	1
Responsibility	x	x		x		x		x			x		x	x	x	x	x	8
Results Orientation		x		x				x	x		x		x	x	x	x	x	7
Results Oriented		x						x		x	x				x	x	x	4
Risk and Uncertainty Management		x		x		x		x		x	x	x	x	x	x	x	x	9
Roles and Responsibility Management		x												x	x	x	x	2
Routine Management														x	x	x	x	1
Schedule Management		x				x		x		x	x	x	x	x	x	x	x	8
Scope Management		x		x				x						x	x	x	x	4
Self-awareness	x	x		x				x					x	x	x	x	x	6
Self-confidence		x													x	x	x	1
Self-control		x				x			x						x	x	x	3
Self-management		x							x						x	x	x	2
Self-taught		x									x	x		x	x	x	x	4
Sensibility		x						x					x	x	x	x	x	4
Social responsibility														x	x	x	x	1
Social Skills	x	x											x		x	x	x	3
Stakeholder Management		x						x		x	x	x	x	x	x	x	x	7
Strategic Planning		x														x	x	1
Strategic Thinking		x				x		x		x				x		x	x	5
Structured Thinking		x													x	x	x	1
Supplier Management		x						x			x		x		x	x	x	4
Supply Chain Management		x													x	x	x	1
Supply Management		x						x				x			x	x	x	3
Systemic View	x	x		x				x										
Systems Thinking		x			x			x										
Team management		x				x		x		x	x	x	x	x	x	x	x	8
Team work	x	x		x						x	x		x		x	x	x	6
Technical Abilities	x	x	x	x		x	x	x		x	x		x	x	x	x	x	11
Time Management		x						x					x		x	x	x	3
Training Abilities								x			x				x	x	x	2

Competence Name x Types of project / Guides	Industry 4.0	Construction	Research and Development	Education	Third Sector	Multiple Projects	Telecommunications	Public Government	Remote Teams	Software Development	Information Technology	Sustainability	Services	Complex	**PMCDF**	**ICB**	**APM**	**Total**
Transparency	x							x			x				x	x	x	3
Vision	x	x									x			x	x	x	x	4
Vision and Imagination		x										x			x	x	x	2
Witty	x															x	x	1
	43	141	5	39	13	29	4	80	21	51	64	37	64	39	125	155	164	

The information collected made it possible to find the competence gaps. It is recommended that institutes, academies, and companies be closer to producing guides that reflect the specific competences needed for project professionals to successfully deliver projects [7], [51].

6. Conclusion

Although the list of competences needed for the project professional to work effectively and efficiently is beneficial, they will not be very useful if these project professionals do not know what type of project they will work with. Thus, generic competences will not benefit these professionals effectively. In this sense, we argue that greater integration is needed between professional project management organizations, academics, and companies to produce specific competence guides by type of projects. However, just creating these guides is not enough, because it is necessary to reflect on these competences strategically. That said, after identifying which competences are required by a certain type of project, a plan is needed to fill professional competence gaps. In this sense, we emphasize that this is the main contribution of this article, which advances the discussions about relating the competences of project professionals to a given type of project.

Another relevant aspect when dealing with competences related to the types of projects concerns the correct selection of project professionals. Thus, for the type of project the professional will perform, a competence diagnosis will improve the quality of the hiring process or even indicate whether the project professional is suitable for a particular type of project. Another relevant aspect refers to education. In this way, universities and training companies can adapt their training programs according to the type of project and include competence diagnosis and the teaching of competences in their program. Finally, the competence diagnosis will also allow companies to analyze professionals according to a benchmark, which allows them to assess their situation vis-à-vis the competition.

The project management competence models, such as the Project Management Competence Development Framework, IPMA Competence Baseline and APM, should take into consideration in their guides that the type of project may affect the relevance of the competence.

This study has some limitations. First, the framework has no empirical tests and is purely based on applied SLR. Databases and articles are limited to the time and place of search, although they represent sources relevant to the area of study. Another limitation refers to the categorization of project types, these being the result of an abstraction process.

As a future research, we suggest the creation of a competence diagnosis model by type of project, using quantitative and qualitative methods for its creation. Thus, a future study will be able to identify the most relevant competences more accurately by type of project.

Appendix A. Competences by Authors

Competence	Authors
4RI Digital Skills	[84]
Ability Breadth	[99]
Acceptance	[70]
Accountability	[37]; [127]
Adaptability	[1]; [7]; [12]; [16]; [43]; [71]; [74]; [99]; [115]; [121]; [128]-[131]
Administrative Skills	[12]; [78; [88]; [91]; [120]
Agile Mindset	[50]; [101]; [132]
Altruism	[31]; [37]; [71]; [72]
Ambition	[12]
Analytical Thinking	[14]; [16]; [31]; [32]; [37]; [49]; [55]; [62]; [65]; [70]-[71]; [74]; [78]-[79]; [82]; [92]-[94]; [114]-[115]; [131]; [133]-[134]
Assertiveness	[31]; [71]; [92]-[94]; [135]
Attitude	[7]; [69]; [71]; [74]; [117]
Authority	[136]
Auto Motivation	[94]; [137]
Autonomy	[7]; [37]; [78]
Bidding Management	[77]; [80]
Build Consensus	[22]; [31];[71]
Business Skills	[7]; [22]; [55]; [71]; [95]; [112]; [138]-[139]
Business Vision	[31]; [92]
Certification	[7]; [31]; [71]; [73]; [74]
Change Management	[31]; [77]; [99]; [122]; [127]; [134]; [140]
Charisma	[12]
Claims management	[98]; [114]
Coaching	[77]; [141]
Cognitive Skill	[1]; [37]; [71]; [77]-[78]; [88]; [97]; [142]
Coherence	[60]
Collaboration	[1]; [37]; [50]; [88]; [101]; [112]; [143]
Commitment	[92]; [100]; [144]
Communication	[1]; [4]; [7]; [12]; [14]; [16]; [22]; [31]; [35]; [37]; [43]; [49]-[51]; [53]-[55]; [58]; [62]; [65]; [68]; [70]; [71]; [73]-[75]; [77]-[78]; [88]-[92]; [94]-[97]; [99]-[101]; [112]; [114]-[117]; [121]-[122]; [125]; [127]; [129]; [131]-[132]; [134]-[135]; [138]-[139]; [141]-[143]; [145]-[154]
Configuration Management	[70]; [77]-[79]
Conflict Management	[1]; [4]; [14]; [16]; [31]; [37]; [50]; [55]; [65]; [71]-[72]; [77]; [82]; [88]; [92]; [96]; [101]; [114]; [122]; [125]; [145]; [135]; [152]
Conscientiousness	[119]
Construction Management	[55]; [73]; [77]; [95]; [138]
Context Analysis	[7]; [31]; [71]; [82]; [97]; [143]; [155]; [156]
Continuous Improvement	[49]; [54]; [77]; [92; [94]
Contract Management	[12]; [55]; [77]; [92]; [95]; [142]
Cooperation	[22]; [35]; [43]; [55]; [79]; [93]-[94]; [128]; [131]
Coordination	[1]; [75]; [88]; [136]; [138]-[139]
Cost Management	[12]; [49]; [65]; [70]; [77]; [92]; [94]; [96]; [98]; [114]; [151]; [165]
Courage	[37]; [71]
Creativity	[12]; [37]; [92]; [115]-[116]; [131]; [147]; [157]; [173]
Credibility	[146]
Critical Analysis	[58]; [88]-[89]; [100]; [128]; [140]
Critical Thinking	[7]; [14]; [16]; [37]; [49]; [55]; [62]; [72]; [92]-[94]; [115]; [165]
Cultural Intelligence	[14]; [31]; [35]; [37]; [50]; [71]; [77]; [112]; [149]
Curiosity	[12]; [43]; [55]; [58]; [92]-[94]; [115]; [121]; [129]
Customer Focus	[50]; [55]; [71]; [82]; [92]-[94]; [122]; [177]
Decision Making	[12]; [16]; [31]-[32]; [49]; [65]; [77]; [88]; [91]; [92]; [94]-[95]; [114]; [129]; [132]; [136]; [144]; [157]
Dedication	[72]
Delegation	[1]; [12]; [16]; [65]; [69]; [77]; [92]; [95]; [114]
Delegation Skills	[91]

Competence	Authors
Developing followers	[71]; [89]; [92]; [133]; [177]
Digital Skills	[37]; [95]
Directive Abilities	[70]; [88]; [94]; [122]
Disciplined	[14]; [35]
Dynamism	[152]
Effectiveness	[14]; [22]; [31]; [71]; [88]; [101]; [112]; [146]; [152]
Emotional intelligence	[1]; [4]; [14]; [16]; [31]; [35]; [37]; [55]; [71]; [92]-[95]; [100]; [130]-[131]; [137] [145]; [167]; [178]-[184]
Empathy	[1]; [14]; [31]; [35]; [37]; [119]; [121]; [129]; [137]
Empowerment	[51]; [55]; [89]; [100]; [112]
Encourage	[88]
Engagement	[31]; [54]; [55]; [71]; [77]; [112]; [143]
Enthusiasm	[31]; [71]
Entrepreneurship	[75]; [77]; [171]
Environmental Awareness	[77]; [92]; [95]-[96]; [150]
Environmental Legislation and Administration	[12]; [77]
Ethic	[4]; [7]; [12]; [31]-[32]; [37]; [88]; [92]; [96]; [99]; [112]; [115]; [122]; [132]; [134]; [142]; [156]
Evaluative Competence	[171]
Experience	[31]; [49]; [73]-[74]; [88]; [90]; [129]
Facilitation	[88]
Feedback Skills	[16]; [51]; [112]
Financial Management	[7]; [12]; [16]; [31]; [71]; [77]; [80]; [91]-[92]; [96]; [116]; [142]; [156]
Flexibility	[7]; [12]; [14]; [50]; [55]; [71]; [74]-[75]; [78]; [88]; [92]-[94]; [117]; [131]; [143]; [147]
Focus	[35]; [88]
Foreign language	[14]; [35]; [50]; [68]; [77]-[79]; [149]
Health management and security	[12]; [65]; [71]; [77]; [82]; [92]-[98]; [114]; [142]
Holistic View	[37]; [55]; [90]; [92]; [122]
Honesty	[22]; [37]; [69]; [94]
Human Resource Skills	[77]; [74]; [77]
Humility	[37]
Influence	[1]; [12]; [31]; [37]; [51]; [55]; [71]; [88]; [94]; [100]; [122]; [125]; [129]; [133]; [141]
Information Technology Skills	[31]; [49]; [55]; [58]; [71]-[72]; [78]; [91]-[92]; [95]-[96]; [115]-[116]; [129]; [131]; [134]
Initiative	[14]; [16]; [31]; [35]; [37]; [51]; [70]-[71]; [88]; [92]; [94]; [96]; [99]; [115]-[116]; [158]
Innovation	[16]; [31]; [35]; [51]; [88]; [71]; [92]; [96]; [99]; [116]; [158]-[160]
Inspiration	[89]
Integration Management	[71]; [77]-[78]; [82]; [88]; [92]; [97]; [151]
Integrative Thinking	[161]; [162]
Intellectual Skills	[157]
Interpersonal Relationship	[7]; [14]; [16]; [22]; [31]; [35]; [37]; [55]; [65]; [68]-[73]; [77]-[78]; [88]; [91]-[92]; [94]; [95]; [99]-[100]; [112]; [135]; [139]; [142]
Interpersonal Skills	[51]; [88]
Intuition	[37]; [88]; [100]-[101]
Inventory Management	[77]
Knowledge Management	[31]; [37]; [71]; [94]; [98]; [112]
Leadership	[1]; [4]; [7]; [12]; [14]; [16]; [22]; [32]; [35]; [37]; [49]; [53]; [60]; [62]; [65]; [70]-[71]; [74]; [77]-[78]; [82]; [88]-[89]; [91]-[94]; [101]; [112]; [114]-[117]; [120]; [122]; [128]; [131]; [141]; [143]-[144]; [154]; [163]
Lean Competence	[84]
Legal Skills	[16]; [31]; [55]; [71]; [77]; [91]-[92]; [156]; [164]
Local Skills	[77]; [99]
Logical Reasoning,	[12]
Loyalty	[69]
Manage Ambiguity	[117]

Competence	Authors
Management of Roles and Responsibilities	[1]; [88]; [165]
Management skills	[72]; [99]; [115]
Marketing Skills	[22]; [77]
Mentoring	[51]; [77]; [88]
Merge and Acquisition	[97]
Meticulous	[7]; [31]; [71]; [78]; [92]; [115]
Monitoring and Control	[16]; [31];]69]; [70]-[71]; [73]; [75]; [77]-[78]; [88]; [90]; [97]; [116]; [122]; [129]; [131]; [140]; [142]
Motivation	[4]; [7]; [12]; [71]; [75]; [77]-[78]; [88]; [91]; [95]; [100]; [133]-[134]
Multiple Project Management	[161]
Multitask	[78]; [122]
Negotiation	[1]; [7]; [16]; [22]; [37]; [43]; [49]; [51]; [55]; [70]-[71]; [77]; [80]; [88]; [91]-[92]; [95]; [97]; [114]-[116]; [122]; [127]; [136]; [152]
Open to New Experiences	[12]; [35]; [70]; [88]; [92]; [115]; [119]
Operational View	[137]
Operations Research Skills	[77]
Optimism	[14]; [31]; [78]; [166]
Organizational Skills	[12]; [16]; [51]; [65]; [69]; [71]; [75]; [77]; [78]; [101]; [115]; [128]; [134]; [152]; [167]
Passion	[121]
Patience	[12]
People Management	[7]; [16]; [35]; [49]; [51]; [69]; [71]; [80]; [92]; [96]; [114]; [142]; [151]; [156]
Persistence	[12]; [134]; [168]
Persuasion	[22]; [93]-[94]; [112]; [154]
Phronesis	[39]; [44]
Planning Skills	[16]; [65]; [69]; [70]-[71]; [75]; [77]; [97]; [116]; [129]; [132]; [138]-[139]; [156]
Proactivity	[16]; [78]; [93]-[94]; [133]; [143]
Problem Management	[77]; [96]; [138]; [165]
Problem-Solving	[12]; [16]; [31]; [35]; [37]; [50]-[51]; [62]; [65]; [78]; [92]; [95]; [114]; [116]; [122]; [129]; [131]; [145]; [147]-[148]; [169]-[170]; [172]
Processual View	[37]
Professionalism	[7]; [90]; [116]
Project Management	[16]; [31]; [49]; [55]; [58]; [71]; [77]; [80]; [82]; [92]; [120]; [146]; [152]; [171]; [173]
Project Management Routine	[174]
Project Management Skills	[22]; [152]
Purchasing Management	[174]
Quality Management	[12]; [31]; [71]; [77]; [79]; [92]; [94]-[98]; [116]; [142]; [156]; [175]
Recruitment Skills	[77]
Reflection	[49]; [153]
Relational Competence	[171]
Reliability	[1]; [4]; [12]; [14]; [31]; [37]; [54]; [71]; [88]; [92]; [94]; [60]; [129]; [157]; [131]; [134]; [141]; [154]; [176]
Resilience	[14]; [35]; [78]; [88]; [95]; [100]; [116]; [122]; [157]; [166]
Resource Management	[12]; [70]; [77]; [79]; [88]-[89]; [96]-[97]; [100]; [115]-[116]; [133]-[134]
Respect	[162]
Responsibility	[14]; [69]; [37]; [78]; [136]; [144]
Results Orientation	[1]; [4]; [14]; [22]; [31]; [35]; [55]; [88]-[89]; [93]-[94]; [134]
Results Oriented	[4]; [70]; [127]; [143]; [156]-[157]; [167]
Risk and Uncertainty Management	[7]; [12]; [16]; [31]; [49]-[50]; [55]; [71]; [79]; [92]; [96]; [98]; [101]; [114]; [125]; [151]; [154]; [177]
Schedule Management	[7]; [31];]43]; [49]; [79]-[80]; [94]; [96]-[98]; [114]; [140]; [151]; [177]; [154]; [156]
Scope Management	[7]; [12]; [31]; [70]; [77]; [82]; [92]; [97]; [125]; [175]; [127]; [151]
Self-awareness	[14]; [31]; [37]; [71]; [88]; [133]; [135]; [137]
Self-confidence	[79]; [132]
Self-control	[12]
Self-management	[135]
Self-taught	[88]; [94]; [100]; [114]; [128]

Competence	Authors
Sensibility	[35]; [71]; [75]; [88]; [133]
Social responsability	[174]
Social Skills	[1]; [37]; [135]; [137]
Stakeholder Management	[4]; [7]; [12]; [31]; [43]; [49]; [65]; [68]; [71]; [73]; [88]; [94]; [96]-[97]; [112]; [119]; [151]
Strategic Planning	[91]
Strategic Thinking	[7]; [49]; [54]; [55]; [70]-[71]; [77]; [88]-[90]; [92]; [112]; [116]; [137]
Strategic View	[77]; [100]
Structured Thinking	[90]
Supplier Management	[78]; [97]; [116]; [177]
Supply Chain Management	[77]; [94]; [96]; [98]; [175]
Supply Management	[12]; [16]; [77]; [80]; [96]-[97]; [114]; [142]; [151]
Systemic View	[14]; [31]; [35]; [37]; [77]; [82]; [92]; [130]; [142]
Systems Thinking	[1]; [31]; [77]; [99]
Team management	[7]; [31]; [51]; [55]; [71]; [74]-[75]; [82]; [92]; [94]; [98]; [122]; [129]; [133]-[134]; [138]-[139]; [152]
Team work	[4]; [12]; [32]; [37]; [60]; [74]; [77]-[79]; [88]; [91]-[92]; [95]; [112]; [114]; [135]; [143]; [145]; [148]; [157]
Technical Abilities	[12]; [16]; [22]; [37]; [49]; [50]-[51]; [62]; [65]; [69]; [72]-[74]; [77]-[78]; [82]; [88]; [91]-[92]; [112]; [116]; [120]; [131]-[132]; [134]; [139]; [143]; [146]; [152]; [185]
Time Management	[16]; [65]; [72]; [77]-[78]; [91]-[92]; [97]; [101]; [116]
Training Abilities	[82]; [129]
Transparency	[22]; [80]; [37]
Vision	[22]; [37]; [71]; [77]
Vision and Imagination	[89]; [115]
Witty	[37]

References

[1] Zuo, J., Zhao, X., Nguyen, Q.B., Ma, T., & Gao, S. (2018). Soft skills of construction project management professionals and project success factors: A structural equation model. Engineering, Construction and Architectural Management, vol. 25, pp. 425-442.

[2] Lundin, R. A., Arvidsson, N., Brady, T., Ekstedt, E., Midler, C., & Sydow, J. (2015). Managing and working in project society. Cambridge University Press.

[3] Alvarenga, J. C., Branco, R. R., Guedes, A. L. A., Soares, C. A. P., & Silva, W. da S. (2019). The project manager core competencies to project success. International Journal of Managing Projects in Business, vol. 13, no. 2, pp. 277–292.

[4] Varajão, J., Silva, H., & Pejic-Bach, M. (2019). Key competences of information systems project managers. International Journal of Information Technology Project Management, vol. 10, no. 3, pp. 73–90.

[5] Lynn Crawford. (2004). Global Body of Project Management Knowledge and Standards in Wiley Guide to Managing Projects, Peter W. G. Morris e J. K. Pinto, 1st ed. USA: John Wiley e Sons, Inc., pp.1150-1196.

[6] Perrenoud, P. (2022, 09). Approche par compétences durant la scolarité obligatoire: effet de mode ou réponse décisive à l'échec scolaire? in: Perrenoud, P. Construire des compétences dès l'école Paris, ESF, 1997. p. 93-110. Available: http://www.unige.ch/fapse/SSE/teachers/perrenoud/php_main/textes.html

[7] Chipulu, M., Neoh, J. G., Ojiako, U., & Williams, T. (2013). A multidimensional analysis of project manager competences. IEEE Transactions on Engineering Management, vol. 60, no. 3, pp. 506–517.

[8] Fereshteh Mansourimoayyed, Colabi, A. M., & Semiari, M. (2020). Explaining the Competencies of Project Managers According To PMCDF Model. International Journal of Supply and Operations Management, vol. 7, no. 4, pp. 322–343.

[9] IPMA. (2015). Individual Competence Baseline for Project, Programme & Portfolio Management (Version 4.0). International Project Management Association, Zurich, Switzerland.

[10] PMI. (2017). Project Manager Competency Development Framework (3rd Ed). PMI, Penssylvania, USA.

[11] APM. (2015, 08). APM's Competence Framework[Online]. Available: https://www.apm.org.uk/resources/find-a-resource/competence-framework

[12] Pariafsai, F., & Behzadan, A. H. (2021). Core Competencies for Construction Project Management: Literature Review and Content Analysis. Journal of Civil Engineering Education, vol. 147, no. 4, pp. 04021010.

[13] Construction Industry Institute. (2022, 09). RS306-1 - Quantitative Measurement of Project Manager Competencies. Available: https://www.construction-institute.org/resources/knowledgebase/knowledge-areas/human-resource-management/topics/rt-306/pubs/rs306-1

[14] Moradi, S., Kähkönen, K., & Aaltonen, K. (2020). Comparison of research and industry views on project managers' competencies. International Journal of Managing Projects in Business, vol. 13, no. 3, pp. 543.

[15] Turner, J.R., & Müller. (2006). R. Choosing Appropriate Project Managers. Matching Their Leadership Style to the Type of Project (1st ed.). PMI, Pennsylvania, USA.

[16] Amoah, A., & Marimon, F. (2021). Project managers as knowledge workers: Competencies for effective project management in developing countries. Administrative Sciences, vol.11, no. 4, pp. 131-144.

[17] Kuliš, M. Š. (2020). Selection of Project Managers: An Overview. Business Systems Research Journal, vol. 11, no. 2, pp. 99–116.

[18] Podgórska, M., & Pichlak, M. (2019). Analysis of project managers' leadership competencies: Project success relation: what are the competencies of polish project leaders?. International Journal of Managing Projects in Business, vol. 12, no. 4, pp. 869–887.

[19] Crawford, L. (2005). Senior management perceptions of project management competence. International Journal of Project Management, vol. 23, no. 1, pp. 7–16.

[20] Shenhar, A.J., Tishler, A., Dvir, D., Lipovetsky, S., & Lechler, T. (2002). Refining the search for project success factors: a multivariate, typological approach. ReDManagement, vol. 32, no. 2, pp. 111-126.

[21] Youker, R. (1999). Managing International Development Projects—Lessons Learned. Project Management Journal, vol. 30, no. 2, pp. 6–7.

[22] Skulmoski, G. J., & Hartman, F. T. (2010). Information Systems Project Manager Soft Competencies: A Project-Phase Investigation. Project Management Journal, vol. 41, no. 1, pp. 61–80.

[23] Pollock, A., & Berge, E. (2018). How to do a systematic review. International Journal of Stroke. SAGE Publications Inc, vol. 13, no. 2, pp. 138-156.

[24] Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review. British Journal of Management, vol. 14, pp. 207-222.

[25] Cook, D. J., Mulrow, C. D., & Haynes, R. B. (1997). Systematic reviews: Synthesis of best evidence for clinical decisions. Annals of Internal Medicine, vol. 126, no. 5, pp. 376–380.

[26] Ouzzani, M., Hammady, H., Fedorowicz, Z., & Elmagarmid, A. (2016). Rayyan-a web and mobile app for systematic reviews. Systematic Reviews, vol. 5, no. 1, pp. 1–10.

[27] da Silva, L. F., Resnitzkyd, M. H. C., Santibanez Gonzalez, E. D. R., de Melo Conti, D., & da Costa, P. R. (2022). Management of Plastic Waste and a Circular Economy at the End of the Supply Chain: A Systematic Literature Review. Energies, vol. 15, no. 3, pp.1–15.

[28] Ahsan, K., Ho, M., &Khan, S. (2013). Recruiting Project Managers: A Comparative Analysis of Competencies and Recruitment Signals from Job Advertisements. Project Management Journal, vol. 44, no. 5, pp. 36–54.

[29] Morris, P.W.G., Crawford, L., Hodgson, D., Shepherd, M.M., & Thomas, J. (2006). Exploring the role of formal bodies of knowledge in defining a profession— the case of project management. International Journal of Project Management, vol. 24, no. 8, pp. 710–721.

[30] Cicmil, S., Hodgson, D., Lindgren, M., & Packendorff, J. (2009). Project Management behind the façade. Ephemera, vol. 9, no. 2, pp. 78–92.

[31] Rezk, S., Whited, G. C., Ibrahim, M., & Hanna, A. S. (2019). Competency Assessment for State Highway Agency Project Managers. Transportation Research Record, vol. 2673, no. 3, pp. 658–666.

[32] González, G. E. G., Casas, G. H. P., & Coronado, C. A. L. (2013). Project Manager Profile Characterization in the Construction Sector in Bogotá, Colombia. Project Management Journal, vol. 44, no. 6, pp. 68–93.

[33] Patanakul, P., & Milosevic, D. (2006). Assigning new product projects to multiple-project managers: What market leaders do. Journal of High Technology Management Research, vol. 17, no. 1, pp. 53–69.

[34] Zhang, F., Zuo, J., & Zillante, G. (2013). Identification and evaluation of the key social competencies for Chinese construction project managers. International Journal of Project Management, vol. 35, no. 5, pp. 748–759.

[35] Moradi, S., Kähkönen, K., Klakegg, O. J., & Aaltonen, K. (2021). A competency model for the selection and performance improvement of project managers in collaborative construction projects: Behavioral studies in Norway and Finland. Buildings, vol.11, no. 1, pp. 1–29.

[36] Suikki, R., Tromstedt, R., & Haapasalo, H. (2006). Project management competence development framework in turbulent business environment. Technovation, vol. 26, no. 5, pp. 723-738.

[37] Marnewick, A. L., & Marnewick, C. (2020). The Ability of Project Managers to Implement Industry 4.0-Related Projects. IEEE Access, 8, vol. 8, pp. 314-324.

[38] Patanakul, P., & Milosevic, D. (2008). A competency model for effectiveness in managing multiple projects. Journal of High Technology Management Research, vol. 18, no. 2, pp. 118–13.

[39] Bouwman, R., & Brohm, R. (2016). Phronetic judgement, an essential competence for a project manager in a complex project environment. International Journal of Business and Globalisation, vol. 17, no. 4, pp. 582–596.

[40] Vidal, L.A., Marle, F., & Bocquet, J.C. (2011). Measuring project complexity using the analytic hierarchy process. International Journal of Project Management, vol. 29, no. 6, pp. 718-727.

[41] Azim, S., Gale, A., Lawlor-Wright, T., Kirkham, R., & Khan, A. (2010). The importance of soft skills in complex project. International Journal of Managing Projects in Business, vol. 3, no. 3, pp. 387-40.

[42] Li, Y., Sun, T., Shou, Y., & Sun, H. (2020). What Makes a Competent International Project Manager in Emerging and Developing Countries?. Project Management Journal, vol. 51, no.2, pp. 181–198.

[43] Havila, V., Medlin, C. J., & Salmi, A. (2013). Project-ending competence in premature project closures. International Journal of Project Management, vol. 31, no. 1, pp. 90–99.

[44] Bredillet, C., Tywoniak, S., & Dwivedula, R. (2015). What is a good project manager? An Aristotelian perspective. International Journal of Project Management, vol. 33, no. 2, pp. 254–266.

[45] Ward, S., & Chapman, C. (2003). Transforming project risk management into project uncertainty management. International Journal of Project Management, vol. 21, no. 2, pp. 97–105.

[46] Silvius, A. J. G., & Schipper, R. (2014). Sustainability in Project Management Competencies: Analyzing the Competence Gap of Project Managers. Journal of Human Resource and Sustainability Studies, vol. 2, pp. 40–58.

[47] Mainga, W. (2017). Examining project learning, project management competencies, and project efficiency in project-based firms (PBFs). International Journal of Managing Projects in Business, vol. 10, no. 3, pp. 454-504.

[48] Trindade, D., Barroso, A. P., & Machado, V. H. (2015). Project Management Efficiency of a Portuguese Electricity Distribution Utility Using Data Envelopment Analysis. Procedia Computer Science, vol. 64, pp. 674–682.

[49] Cha, J., & Maytorena-Sanchez, E. (2019). Prioritising project management competences across the software project life cycle. International Journal of Managing Projects in Business, vol. 12, no. 4, pp. 961–978.

[50] Hidayati, A., Budiardjo, E.K., & Purwandari, B. (2021). Scrum Team Competence Based on Knowledge, Skills, Attitude in Global Software Development. Quality - Access to Success, vol. 22, no. 184, pp. 93-98.

[51] Almeida, F., & Simões, J.(2021). Leadership challenges in agile environments. International Journal of Information Technology Project Management, vol. 12, no. 2, pp. 30–44.

[52] Xue, J., Rasool, Z., Gillani, A., & Khan, A. I. (2020). The impact of project manager soft competences on project sustainability. Sustainability (Switzerland), vol. 12, no. 16, pp. 1–18.

[53] Araújo, C., & Pedron, C. (2016). The importance of soft skills and it project managers' personality type. International Journal of Professional Business Review, vol. 1, no. 1, pp. 40–59.

[54] Perides, M. P. N., Barrote, E. B., & Sbragia, R. (2021). As competências de gestores de projetos que atuam com métodos ágeis e tradicionais: um estudo comparativo.Revista de Gestão e Projetos, vol. 12, no. 1, pp. 11–38.

[55] Chen T., Fu M., Liu R., Xu X., Zhou S., & Liu B. (2019). How do project management competencies change within the project management career model in large Chinese construction companies?. International Journal of Project Management, vol. 37, no. 3, pp. 485-500.

[56] Gray, K., & Ulbrich, F. (2017). Ambiguity acceptance and translation skills in the project management literature. International Journal of Managing Projects in Business, vol. 10, no. 2, pp. 423–450.

[57] Li, Y., Sun, T., Shou, Y., & Sun, H. (2020). What Makes a Competent International Project Manager in Emerging and Developing Countries?. Project Management Journal, vol. 51, no. 2, pp. 181–198.

[58] Klein, J. D., & Kelly, W. Q. (2018). Competencies for Instructional Designers: A View from Employers. Performance Improvement Quarterly, vol. 31, no. 3, pp. 225–247.

[59] Makatsoris, C. (2009). An information and communication technologies-based framework for enhancing project management education through competence assessment and development. Human Factors and Ergonomics In Manufacturing, vol. 19, no. 6, pp. 544–567.

[60] Sołtysik, M., Zakrzewska, M., Sagan, A., & Jarosz, S. (2020). Assessment of project manager's competence in the context of individual competence baseline. Education Sciences, vol. 10, no. 5, pp. 1–14.

[61] Aramo-Immonen, H., Bikfalvi, A., Mancebo, N., &Vanharanta, H. (2011). Project managers' competence identification. International Journal of Human Capital and Information Technology Professionals, vol. 2, no. 1, pp. 33–47.

[62] Brill, J. M., Bishop, M. J., & Walker, A. E. (2006). The competencies and characteristics required of an effective project manager: A Web-based Delphi study. Educational Technology Research and Development, vol. 54, no. 2, 115–140.

[63] Crawford, L., Hobbs, J., & Turner, J.R. (2005). Project Categorization Systems: Aligning Capability With Strategy for Better Results, 1st edition, PMI, Pennsylvania, USA.

[64] Pereira, S. D. A., & Freitas, H. M. R. (2019). The project manager's competencies at the mobile context of project management. Revista de Gestão e Projetos, vol. 10, no. 3, pp. 1–12.

[65] Karki, S., & Hadikusumo, B. (2021). Machine learning for the identification of competent project managers for construction projects in Nepal. Construction Innovation, vol. 23, no. 1, pp. 1–18.

[66] Henderson, L. S. (2008). The Impact of Project Managers' Communication Competencies: Validation and Extension of a Research Model for Virtuality, Satisfaction, and Productivity on Project Teams. Project Management Journal, vol. 39, no. 2, pp. 48–59.

[67] Lundy, V. (2013). Project Leadership Influences Resistance to Change: The Case of the Canadian Public Service. Project Management Journal, vol. 44, no. 4, pp. 45–64.

[68] Amoatey, C., & Hayibor, M. V. K. (2017). Critical success factors for local government project stakeholder management. Built Environment Project and Asset Management, vol.*7*, no. 2, pp. 143–156.

[69] Gomes, C. F., Yasin, M. M., & Small, M. H. (2012). Discerning Interrelationships among the Knowledge, Competencies, and Roles of Project Managers in the Planning and Implementation of Public Sector Projects. International Journal of Public Administration, vol. 35, no. 5, pp .315–328.

[70] Bashir, R., Sajjad, A., Bashir, S., Latif, K. F., & Attiq, S. (2021). Project Managers' Competencies in International Development Projects: A Delphi Study. SAGE Open, vol. 11, no. 4.

[71] Hanna, A. S., Ibrahim, M. W., Lotfallah, W., Iskandar, K. A., & Russell, J. S. (2016). Modeling Project Manager Competency: An Integrated Mathematical Approach. Journal of Construction Engineering and Management, vol. 142, no. 8.

[72] Ahadzie, D.K., Proverbs, D.G., Olomolaiye, P.O., & Ankrah, N.A. (2009). Competencies required by project managers for housing construction in Ghana: Implications for CPD agenda. Engineering, Construction and Architectural Management, vol. 16, no. 4, pp. 353-375.

[73] Zheng, J., Wen, Q., & Qiang, M. (2020). Understanding Demand for Project Manager Competences in the Construction Industry: Data Mining Approach. Journal of Construction Engineering and Management, vol. 146, no. 8, pp. 3-11.

[74] Starkweather, J. A., & Stevenson, D. H. (2011). PMP® Certification as a Core Competency: Necessary but Not Sufficient. Project Management Journal, vol. 41, no. 1, pp. 31–41.

[75] Karlsen, J.T., Farid, P., & Torvatn, T. (2020). Project manager roles in a public change project: the case of a municipal merger. International Journal of Organization Theory & Behavior, vol. 23, no. 2, pp. 155-171.

[76] Lampel, J. (2001). The core competencies of effective project execution. International Journal of Project Management, vol. 19, no. 8, pp. 471–483.

[77] Ijaola, I. A., Omolayo, O. H., & Zakariyyh, K. I. (2020). Project Manager's Skills Acquisition: A Comparative Study of Indigenous and Multinational Construction Firms. Journal of Engineering, Project and Production Management, vol. 10, no. 1, pp. 71–79.

[78] Plaza-Lara, C. (2018). Las competencias del gestor de proyectos de traducción: análisis de un corpus de anuncios de trabajo. Meta, vol. 63, no. 2*6*, pp. 510–531.

[79] Kostalova, J., Bednaříková, M., & Paták, M. (2018). Requirements for competences of project managers in metallurgical companies in the Czech Republic. Metalurgija -Sisak then Zagreb, vol. 57, no. 1, pp. 131-134.

[80] Mutajwaa, P., & Rwelamila, D. (2007). Project management competence in public sector infrastructure organisations. Construction Management and Economics, vol. 25, no. 1, pp. 55-66.

[81] Mohd Derus, M., & Abdul-Aziz, A. R. (2016). Critical technical competencies of public sector project managers in developing countries. Pertanika Journal of Social Sciences and Humanities, vol. 24, no. 2, pp. 587–604.

[82] Irfan, M., Khan, S. Z., Hassan, N., Hassan, M., Habib, M., Khan, S., & Khan, H. H. (2021). Role of Project Planning and Project Manager Competencies on Public Sector Project Success. Sustainability, vol. 13, no. 3, pp. 1421.

[83] Gajdzik, B., Grabowska, S., & Saniuk, S. (2021). A theoretical framework for industry 4.0 and its implementation with selected practical schedules. Energies, vol. 14, no. 4, pp. 940-964.

[84] Whitmore, D., Papadonikolaki, E., Krystallis, I., & Locatelli, G. (2020). Are megaprojects ready for the Fourth Industrial Revolution?. Proceedings of Institution of Civil Engineers: Management, Procurement and Law, vol. 174, no. 2, pp. 49–58.

[85] Yahaya, R., & Ebrahim, F. (2016). Leadership styles and organizational commitment: literature review. Journal of Management Development, vol. 35, no. 2, pp. 190–216.

[86] Schwab, K. (2016). The Global Competitiveness Report. World Economic Forum, vol. 1, no. 1.

[87] Yu, Y., Yazzan D.M., Junjan V., & Iacob, M. (2022). Circular economy in the construction industry: A review of decision support tools based on Information e Communication Technologies. Journal of Cleaner Production, vol. 349, pp. 131355.

[88] Ahmed, R., Philbin, S. P., & Cheema, F. (2021). Systematic literature review of project manager's leadership competencies. Engineering, Construction and Architectural Management, vol. 28, no. 1, pp. 1–30.

[89] Tabassi, A. A., Roufechaei, K. M., Ramli, M., Bakar, A. H. A., Ismail, R., & Pakir, A. H. K. (2016). Leadership competences of sustainable construction project managers. Journal of Cleaner Production, vol. 124, pp. 339–349.

[90] Xiao, Y., Liu, J., & Pang, Y. (2019). Development of a competency model for real-estate project managers: case study of China. International Journal of Construction Management, vol. 19, no. 4, pp. 317–328.

[91] Edum-Fotwe, F. T., & McCaffer, R. (2000). Developing project management competency: Perspectives from the construction industry. International Journal of Project Management, vol. 18, no.2, pp.111–124.

[92] Takey, S.M., & Carvalho, M.M. (2015). Competency mapping in project management: An action research study in an engineering company. International Journal of Project Management, vol. 33, no. 4, pp. 784-796.

[93] Andrew R.J. Dainty , Mei-I Cheng, & David R. Moore (2004). A competency-based performance model for construction project managers. Construction Management and Economics, vol. 22, no. 8, pp. 877-886.

[94] Cheng, M-I., Dainty, A., & Moore, D. (2007). A multifaceted performance excellence framework for project-based organisations. International Journal of Human Resources Development and Management, vol. 7, no. 3/4, pp. 254–275.

[95] Musonda, I., & Okoro, C. (2021). Assessment of current and future critical skills in the South African construction industry. Higher Education, Skills and Work-Based Learning, vol. 11, no. 5, pp. 1055-1067.

[96] Dogbegah, R., Owusu-Manu, D.-G., & Omoteso, K. (2011). A Principal Component Analysis of Project Management Construction Industry Competencies for the Ghanaian. Construction Economics and Building, vol. 11, no. 1, pp. 26-40.

[97] Jabar, I.L., Abdul-Aziz, A., Suresh, S., Renukappa, S., & Enshassi, A. (2019). A Project Management Competency Framework for Industrialised Building System (IBS). Construction. International Journal of Technology, vol. 10, no. 4, pp. 657-666.

[98] Isik, Z., Arditi, D., Dikmen, I., & Birgonul, M. T. (2009). Impact of corporate strengths/weaknesses on project management competencies. International Journal of Project Management, vol. 27, no. 6, pp. 629-637.

[99] Brière, S., Proulx, D., Flores, O. N., & Laporte, M. (2015). Competencies of project managers in international NGOs: Perceptions of practitioners. International Journal of Project Management, vol. 33, no. 1, pp. 116–125.

[100] Suifan, T. (2021). The relationship between the competency level and the efficiency of a project manager: Self-perspective vs. subordinates' perspective. International journal of productivity and quality management, vol. 33, no. 1, pp. 1-25.

[101] Aretoulis, G. N., Papathanasiou, J. B., Zapounidis, K., & Seridou, A. A. (2017). Conscientiousness personality trait defines the competent Greek project manager. International Journal of Business Performance Management, vol. 18, no. 3, pp. 350–380.

[102] Cheng, M.-I., Dainty, A.R., & Moore, D.R. (2005). What makes a good project manager?. Human Resource Management Journal, vol. 15, no. 1, pp. 25-37.

[103] Zika-Viktorsson, A., Sundström, P., & Engwall, M. (2006). Project overload: An exploratory study of work and management in multi-project settings. International Journal of Project Management, vol. 24, no. 5, pp. 385–394.

[104] Archibald, R. D. (1975). Managing high-technology programs and projects (3rd ed). Wiley, New York, USA.

[105] Aria, M., Capaldo, G., Iorio, C., Orefice, C. I., Riccardi, M., Fusco, S., & Siciliano, R. (2018). PLS Path Modeling for causal detection of project management skills: A research field in National Research Council in Italy. Electronic Journal of Applied Statistical Analysis, vol.11, no. 2, pp, 516–545.

[106] Christiansen, J. K., & Vendelø, M. (2003). The role of reputation building in international ReD project collaboration. Corporate Reputation Review, vol. 5, no. 4, pp. 304-329.

[107] Vraniak, L., Mazánek, L., & Konečná, Z. (2017). Competence approaches: review of current concepts and theories. Journal of InterDisciplinedry Research, vol. 7, no. 2, pp. 134–137.

[108] Mumford, M. D. (2003). Where Have We Been, Where Are We Going? Taking Stock in Creativity Research. Creativity Research Journal, vol. 15, no. 2, pp. 107–120.

[109] Llamas, B., Storch de Gracia, M.D., Mazadiego, L.F., Pous, J., & Alonso, J.H. (2019). Assessing transversal competences as decisive for project management. Thinking Skills and Creativity, vol. 31, pp. 125-137.

[110] Muzio, D., Hodgson, D., Faulconbridge, J., Beaverstock, J., & Hall, S. (2011). Towards corporate professionalization: The case of project management, management consultancy and executive search. Current Sociology, vol. 59, no. 4, pp. 443–464.

[111] Williams van Rooij, S. (2013). The career path to instructional design project management: An expert perspective from the US professional services sector. International Journal of Training and Development, vol. 17, no. 1, pp. 33–53.

[112] Araújo, C., & Pedron, C. D. (2016). The Importance of Soft Skills and it Project Managers' Personality Type. International Journal of Professional Business Review, vol. 1, no. 1, pp. 40–59.

[113] Mehta, P. K. (2019). Concrete technology for sustainable development–an overview of essential elements in the Concrete Technology for a Sustainable Development in the 21st Century, Odd E. Gjorv and Koji Sakai. CRC Press, London, England.

[114] Hwang, B. G., & Ng, W. J. (2013). Project management knowledge and skills for green construction: Overcoming challenges. International Journal of Project Management, vol. 31, no. 2, pp. 272–284.

[115] Do Carmo Assis Todorov, M., Kniess, C. T., Lopes, E. L., & Martins, C. B. (2021). Competences of the Executive Secretariat in project management. Gestão e Produção, vol. 28, no. 3, pp. 1–20.

[116] Sarpin, N., Hasan, A. S., Mohd Iskak, M. A., & Sarpin, N. (2021). Competency Requirement for Project Manager in Improving Sustainable Construction Project Success. International Journal of Sustainable Construction Engineering and Technology, vol. 12, no. 5, pp. 311–321.

[117] Stevenson, D., & Starkweather, J. A. (2017). IT Project Success. International Journal of Information Technology Project Management, vol. 8, no. 3, pp. 1–21.

[118] Kivijärvi, H. (2020). Theorizing IT Project Success: Direct and Indirect Effects in a Hierarchical Framework. International Journal of Information Technology Project Management, vol. 11, no. 1, pp. 71-98.

[119] Strang, K. D., & Strang, K. D. (2009). Assessing team members' interpersonal competencies in new product development e-projects. International Journal of Project Organisation and Management, vol. 1, no. 4, pp. 335–357.

[120] Kosaroglu, M., & Hunt, R. A. (2009). New product development projects and project manager skill sets in the telecommunications industry. International Journal of Managing Projects in Business, vol. 2, no. 2, pp. 308–317.

[121] Charleston, B., Gajewska-De Mattos, H., & Chapman, M. (2018). Cross-cultural competence in the context of NGOs: bridging the gap between 'knowing' and 'doing'. International Journal of Human Resource Management, vol. 29, no. 21, pp. 3068–3092.

[122] Andoh-Baidoo, F. K., Villarreal, M. A., Koong, K. S., Cornejo, H., Schmidt, N., Colunga, H., & Mesa, R. (2011). Key competencies for global project managers: A cross cultural study of the UK and India. International Journal of

Business and Systems Research, vol. 5, no. 3, pp. 223–243.

[123] Hodgson, D. & Paton, S. (2016). Understanding the professional project manager: Cosmopolitans, locals and identity work. International Journal of Project Management, vol. 34, no. 2, pp. 352-364.

[124] Gruden, N., & Stare, A. (2018). The Influence of Behavioral Competencies on Project Performance. Project Management Journal, vol. 49, no. 3, pp. 98–109.

[125] Hefley, William E., & Bottion, M. (2021). Skills of junior project management professionals and project success achieved by them. International Journal of Information Systems and Project Management, vol. 9, no. 1, pp. 56-75.

[126] Magano, J., Silva, C., Figueiredo, C., Vitória, A., Nogueira, T., & Pimenta Dinis, M. A. (2020). Generation Z: Fitting Project Management Soft Skills Competencies—A Mixed-Method Approach. Education Sciences, vol. 10, no. 7, pp. 187-211.

[127] Parry, S.B. (1996). The Quest for Competencies. Gellert Publ. Corp.

[128] Kerzner H. (1999). Applied project management: best practices on implementation. Wiley.

[129] Birkhead, M., Sutherland, M., & Maxwell, T. (2000). Core competencies required of project managers. South African Journal of Business Management, vol. 31, pp. 99-105.

[130] Liikamaa, K. (2015). Developing a Project Manager's Competencies: A Collective View of the Most Important Competencies. Procedia Manufacturing, vol. 3, pp. 681-687.

[131] Ekrot, B., Kock, A., & Gemünden, H.G. (2016). Retaining project management competence – antecedents and consequences. International Journal of Project Management, vol. 34, no. 2, pp. 145-157.

[132] Escobar, F., Varajão, J., Takagi, N., & Neto, U. (2022). Multi-criteria model for selecting project managers in the public sector. International Journal of Information and Decision Sciences, vol. 14, pp. 205-242.

[133] Rodriguez, D., Patel, R., Bright, A., Gregory, D., & Gowing, M. K. (2002). Developing competency models to promote integrated human resource practices. Human Resource Management: Published in Cooperation with the School of Business Administration, The University of Michigan and in alliance with the Society of Human Resources Management, vol. 41, no. 3, pp. 309-324.

[134] Cheng, M. I., Dainty, A. R. J., & Moore, D. R. (2005b). Towards a multidimensional competency-based managerial performance framework: A hybrid approach. Journal of Managerial Psychology, vol. 20, no. 5, pp. 380–396.

[135] Shenhar, A., Levy, O., & Dvir, D. (1997). Mapping the dimensions of project success. Project Management Journal, vol. 28, no. 2, pp. 5–13.

[136] Cheng, M., Dainty, A., & Moore, D. (2005a). What makes a good project manager?. Human Resource Management Journal, vol. 15, no. 1, pp. 25-37.

[137] Brahim, E., & Lassad, H. (2022). Systems and methods for a professional competency framework. (U.S. Patent No US2022004966A1). U.S. Patent and Trademark Office. https://worldwide.espacenet.com/patent/search/family/079166873/publication/US2022004966A1?q=pn%3DUS2022004966A1

[138] American Management Association - AMA (2022,09). AMA Skill Assessments, 2021. Available: https://www.amanet.org/resources/skill-assessment

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Information systems project management practice in Portugal - looking at the past to perspective the future

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Abstract:
The study of Information Systems Project Management (ISPM) practice is fundamental for developing knowledge in this field. Over the past few years, several studies have been conducted in organizations by professionals and academics to identify approaches, processes, tools, and techniques, among other relevant aspects of project management practice. The use of these practices can be related to various factors, such as trends in the world of work or even the cultural context. In this way, an insight into the context of a given region can support actions to improve ISPM practice and raise success rates in information systems projects. This paper presents the results of a systematic literature review that seeks to synthesize how project management on information systems is practiced in Portugal and identify opportunities for developing the project management body of knowledge.

Keywords:
information systems; project management; practice; literature review; country; Portugal.

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1. Introduction

It is widely recognized that the proper use of information leads to better organizational planning, decision-making, and results [1]. In business information management, Information Systems (IS) are critical to improve productivity, reduce operational costs, and achieve competitive advantages [2, 3]. Moreover, in an increasingly digital and complex world [4], IS investments require constant attention to keep up with the changes in organizations and their information needs [5].

Projects are one of the ways to accomplish organizational changes [6]. The IS projects can take many sizes and forms, including, for instance, implementation and improvement of systems (e.g., Enterprise Resource Planning, Supply Chain Management, Customer Relationship Management), process improvement using information technology, and infrastructure improvement [7]. Achieving success in IS projects is challenging as it depends on many contextual and organizational variables [8, 9].

Organizations have a high investment in information technology (IT) [10]; thus, project management and IS projects are essential to the success of these investments. Several works aim to characterize organizations' IS project management (ISPM) practice. Some of these works are related to the use of agile methodologies [11, 12], team management [13, 14], business process management [15], and success evaluation [8, 16, 17]. Systematizing ISPM practice in organizations is relevant since it helps envision actions to prepare organizations for future challenges. Based on this opportunity, this research focused on identifying the organizational practice for ISPM. A systematic literature review (SLR) was conducted to understand how organizations in Portugal have been carrying out ISPM. The results achieved allow a characterization of the practice of ISPM and the identification of future research opportunities. Another significant contribution of this work is the proposal of an SLR process for analyzing empirical research on ISPM in specific geographic, to make it possible to compare the realities among different countries in the future.

Following this introduction section, this paper presents the main concepts of IS projects and ISPM in section 2. Then, section 3 describes the research design. Section 4 presents the main results of the SLR, namely the identification and summary of the selected studies. Section 5 discusses the results and the future trends in project management. Section 6 presents the process for replication of future studies. Finally, in section 7, we conclude with the main contributions, limitations, and highlights for further research.

2. Information systems project management practice

Projects are one of the main ways to develop organizations and turn their strategic initiatives into reality [18]. The IS projects can be simple or complex [19], depending on the many different variables involved in the project (e.g., number of business areas affected, number and type of technologies, or team's experience). Some examples of IS projects are integrated systems implementations related to:

- Enterprise Resource Planning (ERP): a comprehensive and integrated software solution used by organizations to manage business processes. ERP systems are designed to centralize and automate key business activities, such as accounting, human resources, inventory management, procurement, and manufacturing [20];
- Supply Chain Management (SCM): a process within businesses that focuses on the planning, execution, and optimization of all activities related to the flow of goods, services, information, and finances from the initial supplier to the final customer [21];
- Customer relationship management (CRM): a customer-focused business strategy that dynamically integrates sales, marketing, and customer care service to create and add value for the company and its customers [22].

Integrated systems are, by definition, complex and challenging to implement [23] because they change business processes and the organization's configuration. However, IS projects are not restricted to these types of projects. IS projects can also involve other variants, such as Business Intelligence [24, 25], Big Data [26, 27], and Blockchain projects [28]. Understanding and managing IS projects is essential to organizational success.

Information Systems Project Management includes using several processes, techniques, and tools to achieve project objectives on time, within budget, and meeting user requirements [29, 30]. Therefore, they are essential to achieve the IS project's success [31]. These practices can be found in project management standards and guides, such as PMBOK - Project Management Body of Knowledge [6], PRINCE2 - PRojects IN Controlled Environments [32], PM2 - Project Management Methodology [33], ISO 21502 [34], and in several scientific works [3, 8, 9, 11, 13, 16, 35-38]. Of the various practices proposed by project management standards and guides and the literature, actually knowing which ones are being used can help direct organizational efforts.

3. Research design

The research design followed the PRISMA methodology [39] and other works [40, 41]. According to these works, an SLR comprises three main phases: Planning, Execution, and Results. The planning phase includes formulating the research question and defining the SLR protocol (rules/restrictions, databases, search strings, and selection criteria). The Execution phase involves conducting the protocol defined for the SLR. Finally, the Results phase considers the presentation and discussion of the results.

This research aimed to identify and analyze published works on ISPM practice, and then systematize the knowledge recovered. Following [39-41], an SLR process consisting of seven steps was defined to be employed in this research. The seven steps of the SLR process were:

1. Definition of the research scope
   Pondering the complexity of IS projects and the diversity of contexts in which they are carried out, it is important to conduct a study limited to a country or an area/region (e.g., group of countries). This option provides insights into the ISPM practice of a country (or an area/region) and, later on, with further studies, enables comparing different realities to understand the context and the practice maturity better. Due to the authors' proximity to the research conducted, it was decided in this research to study the ISPM practice in Portugal.

2. Identification of information sources
   Identifying relevant information sources for research aims to ensure that relevant publications are included in the analysis and that conclusions are based on quality evidence. This ensures that the research is comprehensive, up-to-date, and reliable. Failure to properly define relevant information sources can lead to the exclusion of relevant publications and the inclusion of inadequate or low-quality publications, which can compromise the validity of the results and lead to incorrect or misleading conclusions.

   Identifying sources of information on ISPM practice in a given country or region should include scientific databases or indexers, like Scopus, Web of Science, or Google Scholar, and other sources that allow obtaining the papers published by researchers/scholars in this area of knowledge. In the case of Portugal, there is an open-access scientific database, known as the Open Access Scientific Repositories of Portugal – RCAAP, that was understood to be essential to use.

   Furthermore, it would be useful to identify the works published by professors of ISPM courses in higher education programs for this research. First, a search for ISPM course professors was performed on the websites of Portuguese Universities and Polytechnic Institutes. Then, the names of professors were used to search in the databases and to contact them to obtain suggestions for papers on ISPM practice. In sum, 32 professors of ISPM courses in higher education programs were identified.

3. Definition of inclusion/exclusion criteria
   Inclusion or exclusion criteria were defined in advance and were used to determine which studies would be selected for review and which would be excluded [42]. Inclusion criteria are used to select studies that meet specific predetermined requirements. In contrast, exclusion criteria remove studies that do not meet these requirements or are irrelevant to the research question.

In research that aims to identify the ISPM practice, the inclusion criteria may be related to aspects such as a clear description of ISPM practice, ISPM practice adopted/used by the organization, ISPM practice adopted/used in a specific country/region, or in the case of survey research, it was required that more than half of the respondents should be from the country/region of interest.

In this work, the following inclusion criteria were set:

- The paper should present and describe some aspects of ISPM practice;
- The IPSM practice in the paper must have been adopted/used in IS Projects in Portugal;
- In the case of papers with surveys, at least 60% of the respondents should be from Portugal.

4. Search for works
Given the nature of this study, searches for related work were conducted in three ways:

   - A search in Scopus, Web of Science, Google Scholar, and the RCAAP databases of papers published by professors of the ISPM courses.
   - A search in the Scopus database of papers using a search string with keywords relevant to the research question, namely the keywords “practice”, “project management”, “technologies”, and “information systems” in the title, abstract, or keywords of the papers, as well as terms related to the country or countries of affiliation of the authors. Keywords in the native language related to the country searched also should be considered.
   - Consult/contact researchers/scholars of ISPM courses to obtain suggestions for documents on ISPM practice.

   From the search in the scientific databases of researchers/scholars' works, 57 papers were identified. From the search in Scopus, using the search string, 198 papers were identified. The search string was:

   > TITLE-ABS-KEY (“project management” OR “gerenciamento de projecto” OR “gestão de projeto” OR “gestão do projeto”) AND TITLE-ABS-KEY (practice OR prática OR tool OR ferramenta OR technique OR técnica OR competences OR competencies OR competency) AND TITLE-ABS-KEY (“information system” OR “sistema de informação” OR “tecnologia da informação” OR “information technology”) AND AFFILCOUNTRY (“Portugal”)

   Finally, eight papers were suggested from the contacts made with the researchers/scholars.

5. Study selection
Study selection is critical in conducting SLR, and following a systematic and transparent approach is important [42]. To this end, the following steps have been defined:

   - Remove duplicates;
   - Review titles and abstracts to remove papers that are not directly related to ISPM practice. The goal was to find what practitioners and organizations were actually doing. Note that a research project applying the practice to validate and collect data on usage does not necessarily indicate that the organization is using it and should not be considered an existing organizational practice in this literature review;
   - Apply the inclusion and exclusion criteria.

   By removing duplicate works and analyzing the title and abstract, 33 works remained. After applying the inclusion and exclusion criteria, 27 works about ISPM practice in Portugal were identified and selected for complete analysis.

6. Data Extraction
   The data extraction and collection should be carried out consistently and standardized [42]. In this sense, it is important to consider what data should be extracted to identify ISPM practice. In the context of this work, it was considered necessary to create a shared spreadsheet in the cloud to record the list of professors, the selected articles, the identified ISPM practice, and a matrix that associates the papers with the proposed categorization of ISPM practice.
7. Synthesis and Discussion of Results
   Finally, in synthesizing and discussing results, it is important to summarize the results of the studies included in the systematic review [42]. In this work, the synthesis essentially consists of presenting a summary of the studies analyzed, focusing on identifying ISPM practice. These ISPM practices are organized into ten categories.

Figure 1 summarizes the SLR process developed in this research work.

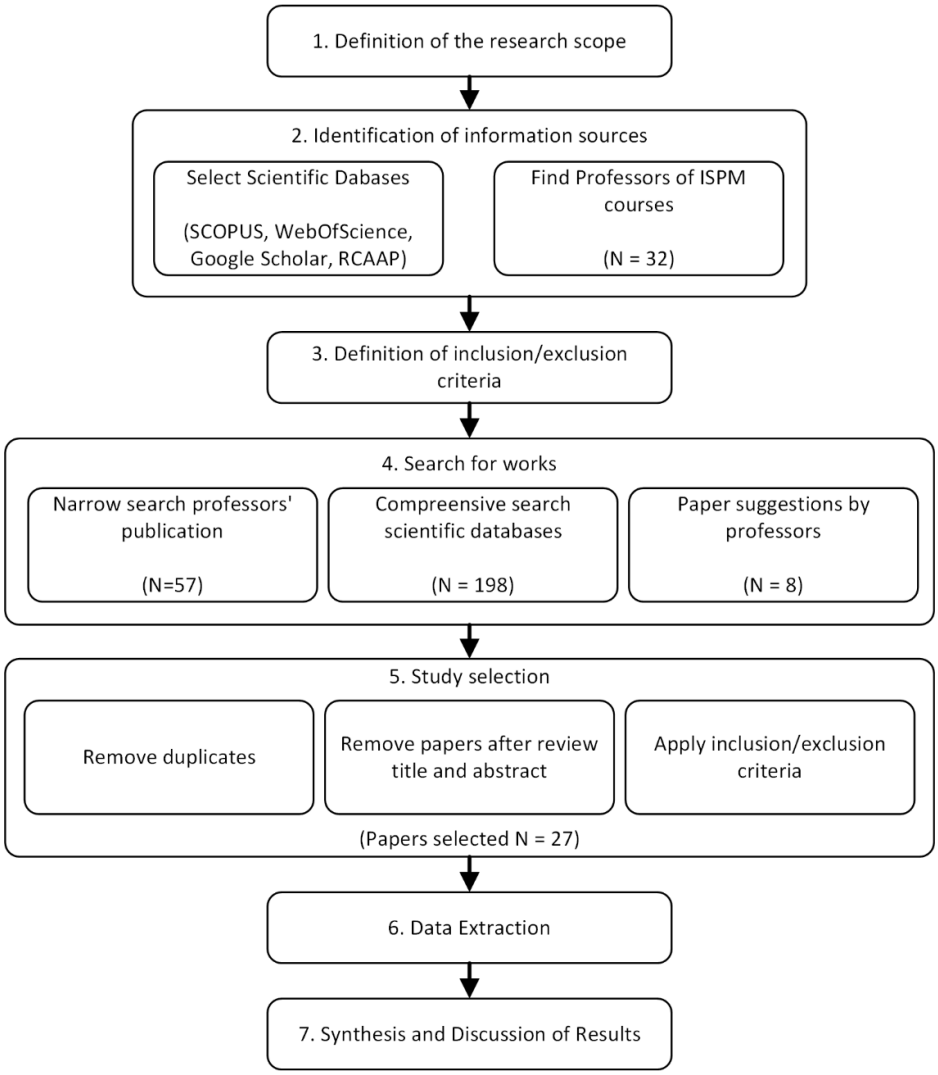

Figure 1. SLR process

4. SLR results

Table 1 presents the 27 papers selected during the SLR process, with information about authors, references, work titles, and proposed categorization. The categorization of each paper was defined according to their results related to ISPM practice. The twelve categories defined are: Agile, quality management, success evaluation, success factors, benefits management, project team, processes, success management, competences, tools and techniques, risk management, and general practices.

Table 1 - Selected works in SLR process

Id	Authors / Citation	Year	Work Title	Category
1	Varajão, J., Cardoso, J., Gonçalves, D., and Cruz, J. [43]	2008	Analysis of software development project management in large Portuguese companies	General
2	Catarino, M., Gonçalves, D., Pereira, A., and Varajão, J. [44]	2009	Software projects' most important activities of quality management: A Delphi study	Quality management
3	Paiva, A., Varajão, J., Domínguez, C., and Ribeiro [16]	2011	Key aspects in the assessment of success in software development projects. Is there a relationship with what is considered in other industries?	Success evaluation
4	Rodrigues, J. S., Costa, A. R., and Gestoso, C. G. [45]	2014	National Culture and Planning and Control of Projects in Portugal	General
5	Varajão, J., Dominguez, C., Ribeiro, P., and Paiva, A. [35]	2014	Critical success aspects in project management: Similarities and differences between the construction and the software industry	Success factors
6	Varajão, J., Dominguez, C., Ribeiro, P., and Paiva, A. [46]	2014	Failures in software project management - are we alone? A comparison with construction industry	Success evaluation
7	Varajão, J., and Trigo, A. [47]	2016	Evaluation of IS project success in InfSysMakers: an exploratory case study	Success evaluation
8	Fernandes, T. M., Gomes, J., and Romão, M. [48]	2017	Investments in E-Government: A benefit management case study	Benefits management
9	Silva, L., Varajão, J., Dominguez, C., and Moura, I. [49]	2017	Motivations for high-performance teams of information systems projects	Project team
10	Varajão, J., Colomo-Palacios, R., and Silva, H. [7]	2017	ISO 21500:2012 and PMBoK 5 processes in information systems project management	Processes
11	Varajão, J., Magalhães, L., Freitas, L., Ribeiro, P., and Ramos, J. [50]	2018	Implementing Success Management in an IT Project	Success management
12	Varajão, J., and Carvalho, J. A. [51]	2018	Evaluating the Success of IS/IT Projects: How Are Companies Doing It?	Success evaluation
13	Ribeiro, A., and Domingues, L. [11]	2018	Acceptance of an agile methodology in the public sector	Agile
14	Laranjeira, M., Trigo, A., and Varajão, J. [17]	2019	Success of Software Development Projects in Portugal - preliminary results	Success evaluation
15	Moura, I., Dominguez, C., and Varajão, J. [52]	2019	Information systems project teams: factors for high performance	Project team
16	Tereso, A., Ribeiro, P., Fernandes, G., Loureiro, I., and Ferreira, M. [36]	2019	Project Management Practices in Private Organizations	General
17	Varajão, J., Silva, H., and Bach, M. 2019. [53]	2019	Key Competences of Information Systems Project Managers	Competences
18	Silva, F., Jerónimo, H., and Vieira, P. [14]	2019	Leadership competencies revisited: A causal configuration analysis of success in the requirements phase of information systems projects	Competences

Id	Authors / Citation	Year	Work Title	Category
19	Teixeira, A., Oliveira, T., and Varajão, J. [25]	2019	Evaluation of Business Intelligence Projects Success – a Case Study	Success evaluation
20	Varajão, J., Fernandes, G., and Silva, H. [54]	2020	Most used project management tools and techniques in information systems projects	Tools and techniques
21	Tam, C., Moura, E. J. C., Oliveira, T., and Varajão, J. [12]	2020	Factors influencing the success of on-going agile projects	Agile
22	Gonçalves, A., Oliveira, P. M., and Varajão, J. [55]	2021	Success Factors of Information Systems Projects in Portuguese Public Institutions	Success factors
23	Moura, I., Dominguez, C., and Varajão, J. [13]	2021	Information systems project team members: factors for high performance	Project team
24	Varajão, J., and Amaral, A. [56]	2021	Risk Management in Information Systems Projects: It Can Be Risky Not To Do It	Risk management
25	Varajão, J., Trigo, A., Pereira, J. L., and Moura, I. [57]	2021	Information systems project management success	Success evaluation
26	Pereira, J., Varajão, J., and Takagi, N. [8]	2022	Evaluation of Information Systems Project Success – Insights from Practitioners	Success evaluation
27	Varajão, J., and Takagi, N. [38]	2024	Information systems project managers technical competences – perceived importance and influencing variables	Competences

4.1 General, processes, and tools and techniques

Five of the 27 papers reviewed present results about transversal topics on ISPM. The papers identified in this category are from the authors Varajão et al. [43], Rodrigues et al. [45], Varajão et al. [7], Tereso et al. [36], and Varajão et al. [54]. The following is a summary of each of these papers.

Varajão et al. [43] surveyed 20 project managers working in large Portuguese companies. The survey focused on evaluating how project management was perceived in projects in these companies. From this survey, it was concluded that in 2008, few project managers of Portuguese companies used internationally recognized project management standards and guides, such as the PMBOK (15%) or even maturity assessment models (5%). The low adherence is reflected in their inadequate training (10%) in project management and the high use of previous experiences (85%) to estimate deadlines to the detriment of good practices presented in project management standards and guides.

Rodrigues et al. [45] aimed to analyze the hypothesis that the Portuguese culture is little adept at planning and controlling projects, in contrast to the culture of other countries. For this, they surveyed 634 professionals involved in projects in Portugal about which planning and control processes were used in their projects. They compared the results obtained with a similar survey applied to project managers in the United States, concluding that there was no significant difference in adopting these processes between these two cultures. Notably, this research was conducted with project managers in Portugal with high educational levels and considerable experience in the management area, thus probably already well-familiarized with the current project management methodologies.

Varajão et al. [7] conducted, between 2014 and 2015, an online survey on information systems project management, which was made available to many groups of information systems project managers. The survey contained a list of 47 processes organized into ten knowledge areas (integration, scope, time, cost, quality, human resources, communication, risks, acquisition, and stakeholders) based on both PMBOK 5 and ISO 21500:2012. A total of 107 complete responses were collected, representing 472 projects. The results showed that all 47 processes were used at least occasionally in the last projects managed by these managers, even with 53.3% of these managers not having some certification in Project Management and not using the ISO 21500:2012/PMBOK methodology in their projects (62.6%). Also, according to the results of this work, the most used processes are from scope, time, and cost; among the least used processes are from quality and risks, which may explain the still frequent failures in project management, considering that risk

management works with the anticipation of significant changes in the project environment and planning to control their effects. The study concludes that greater use of risk management processes and more substantial experience in project management are essential factors for success in complex projects.

Tereso et al. [36] conducted an online survey with members of two professional associations of project managers from Portugal (the PMI Portugal Chapter and the APOGEP - Portuguese Association of Project Management) to understand the leading project management practices used in four different areas of the economy in Portugal. In this survey, the area with the highest number of answers was "information technology and communication", with 48.4% of the answers. The most used practices are from the planning group ("Gantt chart", "activity list", "baseline plan", "project scope statement", "requirements analysis") and from the monitoring and control group ("progress meetings", "progress report", "change request").

Varajão et al. [54] present the results from a survey on the main techniques and tools used by IS project managers. Accordingly to this study, the five most used techniques and tools were "kick-off meetings", "progress meetings", "progress reports", "requirements analysis", and "activity list". In contrast, techniques such as "earned value management", "quantitative risk analysis", and "critical chain method and analysis" showed up at the bottom of the list, which is concerning considering that these are essential techniques to assist in the project management process. One explanation for the low use of these techniques may be that they are advanced and complex techniques, and therefore their adoption requires more specialized project managers.

4.2 Success evaluation, success factors, and success management

The topics related to the success evaluation, success factors, and success management of ISPM are addressed in 11 of the 27 papers reviewed. The identified works are presented below.

Paiva et al. [16] presented the results of a survey that counted the participation of 80 project managers, focusing on identifying and prioritizing the main aspects considered in evaluating the success of projects in software development and construction. From the literature review that supported the study, the following were identified as the main aspects considered in the assessment of project success: "finish the project within the predefined timeframe"; "finish the project within budget"; "finish the project according to the specified requirements"; "optimally use the available resources"; "present solutions with superior technological performance"; "achieve project acceptance by the customer"; "keep the team motivated"; and "finish within quality limits". Regarding the prioritization of aspects, the aspect considered to be the most important in evaluating software projects' success is finishing the project according to the specified requirements. For construction project managers, the most critical aspect is to complete the project within budget. The authors conclude that typical aspects related to meeting budget, schedule, and scope are still those considered most important, regardless of industry, even though other aspects are also considered.

Varajão et al. [35] explored the critical factors for the success of project management, having identified in the literature the following success factors: "project planning"; "top management involvement"; "customer involvement throughout the process"; "well-defined objectives and requirements"; "cost control"; "project monitoring"; "frequent control checkpoints"; "project strategy"; "involvement of the team in achieving the objectives"; "project manager efficiency"; "way of resolving conflicts"; and "communication efficiency". These aspects were ranked in importance by surveying 40 construction project managers and 40 software development project managers. The results show that "project planning" and "well-defined objectives and requirements" occupy the first two places in the ranking of importance for both industries, demonstrating strong agreement between project managers. Regarding the least important factors, two factors coincide in both industries: "frequent control checkpoints" and "way of resolving conflicts". Overall, the authors conclude that despite the significant differences between the industries studied, the most important factors in project management are similar, contributing to researchers, professionals, and training institutions focusing on these.

In addition, Varajão et al. [46] discussed the success of software and construction projects based on the Iron Triangle's three dimensions (scope, cost, and time). The authors report that in the case of software development projects, about 72% of the completed projects meet the expected costs, 70% meet the established scope, and only 59% are completed within the initially defined deadlines. On the other hand, concerning civil construction projects, the results show that

about 70% of the completed projects meet the expected costs, 88% meet the established scope, and 72% are completed within the initially defined deadlines. The authors conclude that software development and construction projects' results are similar and slightly more favorable for construction projects. This is particularly visible in the results of the scope dimension, something that, according to the authors, can be justified by the fact that in construction projects, there is a clear separation between the planning and design phases and the construction and implementation phases and, consequently, a reduction of risks.

Varajão and Trigo [47] presented an exploratory case study in a software company, reporting project evaluation results in terms of project management practices, definition of the evaluation process, criteria used to measure success, evaluation of success, and overall project results. This company internally uses PMBOK and PRINCE2 project management processes in addition to the OPM3 maturity assessment model. Interviews were conducted face-to-face or via videoconference with portfolio and project managers to understand the success evaluation processes used by the company in ISPM. The work concluded that, besides the Iron Triangle (scope, cost, deadlines), the company also implements critical processes that explain this high success rate, such as: "ensuring that the business objectives are taken into account in the project"; "ensure that the customer's business objectives are taken into account in the project"; "user satisfaction"; "customer satisfaction"; "operational Team satisfaction"; "sponsor satisfaction"; and "analysis of product/service delivery quality".

Varajão et al. [50] presented the preliminary results of the first phase of implementing a success management process in an IT project in a multinational company. According to the authors, these results show that, with a slight increase in management effort, the implementation of a success management process allows for a precise definition of what success means in the context of a project, a better understanding of the different perspectives of the participating stakeholders, a greater focus on what is most important to achieve project success, unbiased identification, the definition of criteria to evaluate success, and the definition of milestones to carry out the evaluation. Concerning IT project success factors, the following have been identified in this work: "commitment of all team elements in the development of the work"; "availability of the technological infrastructure"; "detailed planning of the project's activities"; "work carried out by sub-teams"; "good communication management"; "fulfillment of the communication rules"; "good planning of meetings"; "knowledge management inside team"; "promote the teamwork over individual work, i.e., task sharing"; "satisfaction and motivation"; "team punctuality"; "good workplace conditions"; "good team relationship"; "team trust"; "technical knowledge needed for developing the solutions"; and "availability of information necessary for the project development".

Varajão and Carvalho [51] described an exploratory study that inquired ten companies about their project success evaluation practices. According to the authors, the results show that, regardless of company size, sector, or project management methodology adopted, project success evaluation is currently an informal and rudimentary process, focused mainly on the success of project management and not on the success of project outcomes. Given the importance and complexity of project success evaluation, companies should define and implement systematic success management processes to improve project performance and expected benefits. Unfortunately, this does not seem to be happening in practice.

Laranjeira et al. [17] presented the preliminary results of research conducted to characterize the success of software development projects in Portugal. Through a questionnaire answered by 202 managers or team members of software development projects, it was possible to assess that most respondents consider: (1) that the project in which they participated has achieved or was close to achieving total success; (2) that after the end of the project, most customers made maintenance contracts and/or hired new projects; (3) that there is growing importance assigned to certifications; and (4) that there is increasing use of agile methodologies in project management. Also, according to the authors, the results reveal high levels of success, contrary to the idea of failure that has predominated in recent decades.

Teixeira et al. [25], through 11 interviews, analyzed how success is evaluated in a large company in Portugal in Business Intelligence (BI) projects. Among the main conclusions are: the quality of BI software is a relevant success factor; there is the need to formally define the process for evaluating the success; the success of a BI project should be assessed along the project lifecycle; some important criteria are sales results, the number of customers, sales margin,

optimization and standardization of information, and people performance; All the people involved in a business intelligence project should also be involved in its evaluation.

Gonçalves et al. [55] presented a model of success factors for information technology and information systems projects in public institutions. This model resulted from a literature review, six cases of Portuguese central government and local government organizations, and a questionnaire-based survey. In total, 44 success factors for IS/IT projects carried out in public institutions were identified by the authors. The proposed model suggests the organization of the success factors into nine categories according to their affinity: "organization and environment"; "pre-project"; "project"; "scope"; "project manager and team"; "stakeholders"; "suppliers"; "customers and users"; and "monitoring and control". According to the authors, the success factors with the highest levels of importance in local government are: "definition of project goals and final objectives"; "leadership capacity of the project manager"; and "motivation of the project execution team". These factors belong to the categories of scope and project manager and team. It is also noted that the importance of these factors is consistent with the results of the works found in the literature focusing on the public sector. Concerning the results obtained for the central government, the factors considered to be most important are: "leadership ability of the project manager"; "formalization and presentation of the project objectives in a clear way"; and "adequate resources for the project, particularly internal human resources with the skills needed to operate the information system". These factors belong to the categories scope, project manager and team, and organization and environment. For other types of public administration, the factors considered most important are: "definition of final project goals and objectives"; "formalization and presentation of project objectives in a clear way"; and "detailed definition of the project scope". These factors are found in the scope category.

Varajão et al. [57] aimed to provide new insights into the success of information systems project management. The work presents and discusses the 107 responses from an international survey comprising 472 projects, mainly in Portugal. The results show that ISPM is achieving high levels of success; however, a minority of projects end without changes in scope, schedule, or cost. In addition, the results show that scope, schedule, or cost changes are frequent in this type of project and do not significantly affect the perception of success.

Pereira et al. [8] presented the results of an exploratory survey of project managers on evaluating information systems project success. Overall, the results show that the assessing success process is often not formally defined or even put into practice. Regarding the criteria for evaluating success, the Iron Triangle criteria remain the most frequent. Often, projects' reported success results from perceptions rather than formal evaluations. Furthermore, a limited view of project success - focusing only on time, cost, and scope - can lead to projects being managed based on incomplete objectives, leading to dissatisfaction among different stakeholders.

4.3 Project team performance and project managers' competences

A total of seven papers address topics related to teams and project managers' categories, with a particular focus on the technical and behavioral skills that are most relevant to IS projects. The identified papers are presented below.

The works of Silva et al. [49], Moura et al. [52], and Moura et al. [13] present results about IS project teams with high performance. The focus of this research was identifying a set of aspects that contribute to the motivation of team members, according to their perspectives. A case study was used with a group of IT/IS companies (holding) in Portugal as a research method. The main motivating aspects identified were: "financial incentives" (e.g., profit sharing, overtime pay, better pay); "non-financial benefits" (e.g., time off, flextime); "management/leadership" (e.g., allocation of tasks in a fair way, involvement of the manager in the team, seeking that the team is in tune with the project objectives); "knowledge" (e.g., to know the tools well, to know the context in which one is working, to participate in training); and "working conditions" (e.g., to have adequate equipment, accessibility).

Varajão et al. [53] analyzed with project managers the importance of a set of 47 competencies listed in ICB 3.0 and added the resilience competency to enable success in ISPM. The competencies were grouped into three different groups: "technical"; "behavioral"; and "contextual". Of the 12 highlighted competencies in the survey, four were technical competencies, seven were behavioral competencies, and one was contextual, showing the importance of soft

skills in the profile of an IS project manager. In addition, the four most frequently mentioned competencies were: "communication"; "engagement and motivation"; "project requirements and objectives"; and "leadership".

Silva et al. [14] explored the types of leadership competencies most relevant for activities in the requirements phase in IS projects. Over 30 semi-structured interviews were conducted in 12 of Portugal's largest IS companies. As a result, in general, intellectual, emotional, and managerial competencies are much more present in conceptual and interactive activities (from initiation to specification). As leadership depends on emotional issues, emotional competence is more present in activities with more stakeholder interaction. As far as intellectual competencies are concerned, the analysis considers them less relevant than their counterparts, although they are present in activities that need to present a viable solution. Surprisingly, managerial competencies are present in all activities except validation.

Varajão and Takagi [38] explored the technical competencies of IS project managers. The data was collected through a survey in several countries, with most respondents from Portugal. The technical competencies of IS project managers that stood out were: "communication management"; "defining project requirements and objectives"; "teamwork"; "stakeholder management"; and "scope and deliverables management". The results also show the relevance of project managers' experience since it influences the perceived importance of 45% of the competencies under study.

4.4 Agile ISPM practice

In the Agile category, two studies were identified related to Agile methodologies and the success factors of Agile software development projects. The identified papers are presented below.

Ribeiro and Domingues [11] presented the implementation process of an agile software development methodology based on Scrum, customized for a Portuguese public organization, and tested its acceptance. The public organization in question is responsible for the IS of a specific Portuguese public sector. To verify the acceptance of the proposed methodology, a workshop was held with 16 participants, the equivalent of 90% of the organization's project managers. In conclusion, the general results were positive despite identifying some resistance and disagreement about the implemented agile methodology. In this sense, 73% of the respondents considered having a single software development methodology in the organization important - something that did not exist. Still, more than half of the respondents considered the methodology adequate to the organization's context.

Tam et al. [12] proposed a model of five personal factors that influence the success of software development projects, success being considered in terms of cost, time, and customer satisfaction. After a survey with 216 agile practitioners from different areas in Portugal, the results suggested that the constructs "team capability" and "customer involvement" are the main factors contributing to the success of agile software development projects. In addition, the constructs "personal characteristics", "training and learning", and "societal culture" had no evidence of contributing to success in the researched context.

4.5 Benefits, quality, and risk management

Three papers were identified regarding the categories related to benefits, quality, and risk management. The identified papers are presented below.

Catarino et al. [44] conducted a survey using the Delphi methodology with 30 experts in quality management. The experts were asked to rank 24 different quality management activities, considering the degree of importance in a software development project. After two rounds of analysis, it was possible to reach a consensus order of the activities and divide them into three groups: activities that are critical to a project and always need to be performed, such as "define a project plan" and "identify and define the critical project aspects"; very important activities, which are activities that should be performed whenever possible such as "perform change management" and "produce reports to customers"; and important activities, which are activities that can be performed whenever possible such as "define a metrics plan", and "audit the project according to the quality plan".

Fernandes et al. [48] applied a study focused on benefits management in an online youth recruitment program for the Public Administration in Portugal (PEPAC Program) to make this service more efficient. Using methodologies such as

direct observation, reading available documentation, database searches, and interviews with some of those responsible for implementing the program, it was possible to identify the macro benefits achieved in each service process and how to interconnect them to achieve their goals better. The macro benefits analyzed were: "improved quality of service"; "cost reduction for applicants"; "cost reduction for the public administration"; "increased effectiveness of the program"; "increased effectiveness of public services"; and "increased decision-making capacity for managers". In addition, an online survey with candidates for this recruitment was also conducted to analyze the satisfaction of customers/users with the service.

Varajão and Amaral [56] analyzed data from a survey of project managers about the use of risk management processes within IS projects. The survey concludes that processes in the area of risk management occupy the lowest utilization rates in the project development cycle. Since risk management involves the adaptability of a project to positive or negative changes that occur throughout its execution, the low importance of these processes within the project management cycle may explain the still high failure rate in ISPM.

5. Discussion

The results of the SLR on ISPM practice in Portugal reveal the complexity of the topic, with different perspectives of analysis, namely, the type of project management approach, the various existing tools and techniques, the competencies required for its execution, the success factors and, more recently, the concerns with the method of evaluation and management of project success.

Over time, there has been an evolution in the methodology used in project management, starting with ad hoc initiatives that become more formalized and led to the development of standards that try to include all aspects of project management. Given the complexity that some of these standards reached, they were no longer viable for conducting smaller projects, so naturally, lighter project management methodologies emerged, such as the ones based on agile approaches. However, the evolution does not stop, and nowadays, many organizations use both types of methodologies, or even a fusion of methodologies, named hybrid methodologies (see Figure 2).

Concerning formalism in project management approaches, one can also notice an evolution over the years toward adopting methodologies for project management. If, in 2008, few companies used well-defined methodologies in project management [43], this is no longer true in recent years. In the research by Laranjeira et al. [17], Paiva et al. [16] and Pereira et al. [8], it is possible to verify that only 16.6% of the project managers indicated that they did not use any formal project management methodology when conducting their projects. It is also noteworthy that project managers not only claim to use the methodologies but, in fact, know them. For example, the study by Varajão et al. [7] mentions that all project managers used, even if occasionally, the 47 processes described in PMBOK5 and ISO 21500:2012. These results are consistent with the international scenario where project managers have increasingly adopted the best practices in project management over time.

Regarding the use of tools and techniques, it is possible to observe, on the one hand, their evolution with the recent exploitation of tools and techniques in the field of artificial intelligence, for example, at the level of the selection of team members [58]. On the other hand, project managers exploit usual tools and techniques in project management, such as "Gantt chart", "activity list", "baseline plan", "project scope statement", "requirements analysis", "progress meetings", "progress report", "change request", "kick-off meeting", "value management", and "quantitative risk analysis", among others [36, 54]. IS project managers need to keep up with the trends in technologies and IS. Otherwise, they will lose competitive advantages over others, and they will continue to look for the latest tools and techniques that can help them conduct projects, such as those in the field of data analysis, whether on a small or large scale (big data), artificial intelligence, among other emerging technologies (see Figure 2).

The lack of hard and soft skills has been a constant concern in project management because, without capable teams, it is difficult to achieve good results with projects in an increasingly competitive world. It is possible to see from the studies listed in this work the need for these professionals to have the following competencies [38, 53]: "communication management"; "definition of project requirements and objectives"; "teamwork"; "stakeholder management";

"management of project scope and deliverables"; "team engagement and motivation"; "leadership"; "reliability"; "results orientation"; "conflict and crisis management"; "project team orientation"; "resilience"; and "ethics". As can be seen from the list of competencies presented, although the project manager should continue to master the technical competencies associated with their profession, they should place much more emphasis on the domain of soft skills, something that has been identified as one of the trends in the area of ISPM (see Figure 2). These competencies are also crucial for the other members of the team. Furthermore, knowing the competencies required for IS projects can help hire or qualify project managers with these competencies [59].

A trend imposed with the pandemic and previously identified in the work of Varajão, Trigo, and Rodrigues [60] is the practice of remote work. Remote work can include new tools, techniques, and different competencies, such as the ability to self-motivate and organize your own work.

Finally, the dimension of success and its management practices, which, although it does not appear in the trends in ISPM (see Figure 2), has been a concern since the concept of the project emerged and will remain so as long as there are projects to be carried out, whether or not in the field of IS.

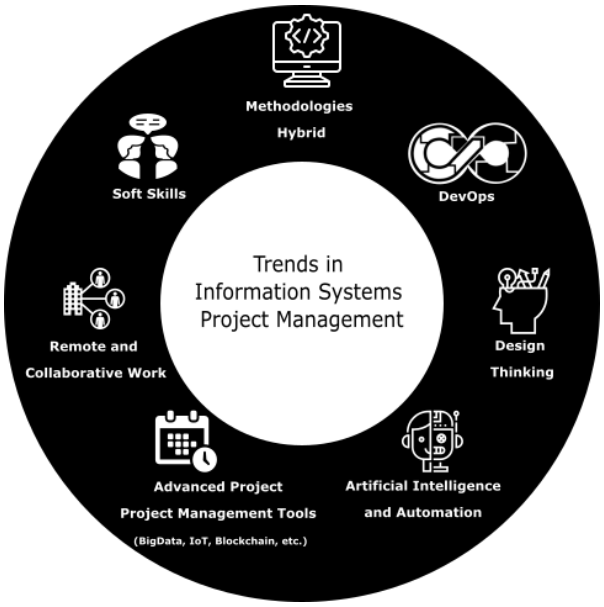

Figure 2. Trends in ISPM. Source: [60]

6. Process for replication studies

With the definition of the research method and with the experience and lessons learned from its execution, we propose a process for replication studies with ten steps to perform this process focused on characterizing project management practice in information systems projects in a region or country. This proposed process can be adapted to look for other aims, such as future practices in project management information systems projects, focusing on what practices the researchers are studying/considering. The ten steps of the process are summarily presented in Figure 3 and described in the next.

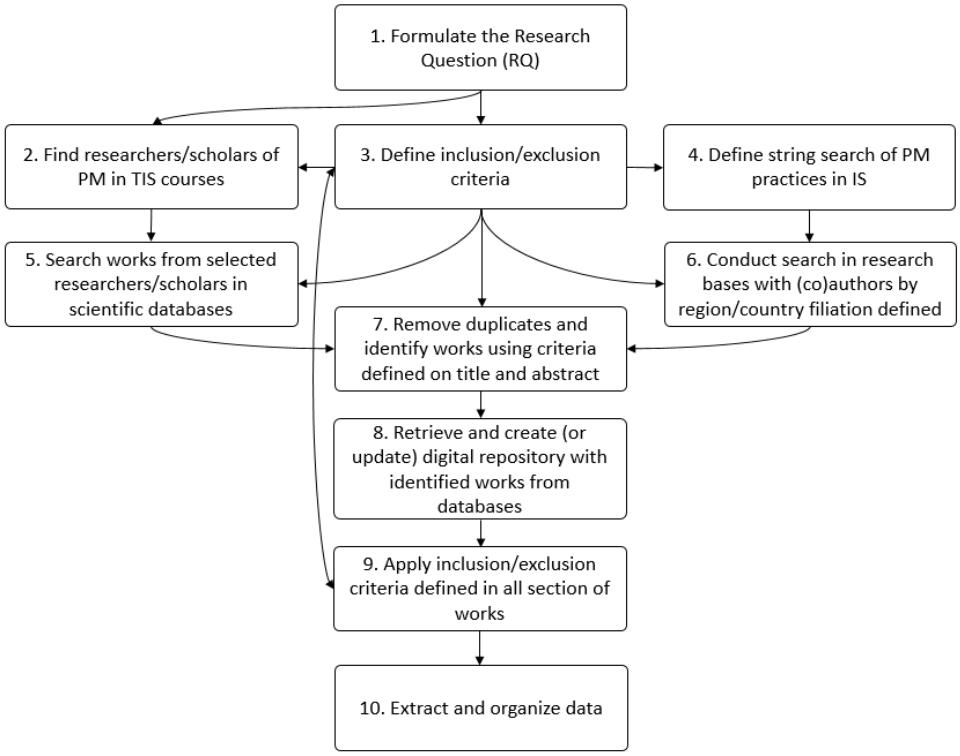

Figure 3. Process for ISPM practice replication studies

1. **Formulate the Research Question (RQ)**: The original research question of this work is focused on information systems project management practices. However, this can be adapted to research practices or even what is being taught in academia to manage information systems projects. This step aims to define the scope of the research, focused, for example, on practices, research, or even the teaching of information systems project management. Also, depending on the geographical dimension, the study can contemplate a region within a country or even consolidate groups of countries.
2. **Find researchers/scholars of PM in IT/IS courses**: Discovering the researchers is one way to find published scientific works on project management practice in a region or country. The researchers can also be project management scholars in technology and information systems courses. In other words, finding the researchers/scholars of project management in technology and information systems courses in higher education can help to find research works related to project management practices (or other research questions of ISPM). These researchers/scholars can be found in different ways; groups of practitioners can also be a good source.
3. **Define inclusion/exclusion criteria**: The inclusion/exclusion criteria will guide the selection of the works found. Inclusion/exclusion criteria may be related, for example, to a clear description of information systems project management practice; the practice is, in fact, being used by the organization; the described practice should have been applied in the country/region of interest; in the case of works with surveys, more than half of the respondents should be from the country/region of interest.
4. **Define string search of PM practices in IS**: A string should be developed based on the defined inclusion criteria to extend the search and try to find work by other researchers. Should be used word variations with "practice", "project management", "technology" and "information system" with a search in the title, abstract, and keywords. There may be works in the native language of the country, this also needs to be considered in the query variations. If the researchers focused on the research practices, the string search needs to be adapted.

5. **Search works from selected researchers/scholars in scientific databases**: This step is focused on searching for papers addressing ISPM practice in the profile of project management researchers/scholars in technology and information systems courses. Google Scholar, ORCID, and Scopus are examples that consolidate the results by author. If there are databases of research works from the country of interest, they should also be considered in the search.
6. **Conduct search in research bases with (co)authors by region/country filiation defined**: To identify articles from the region/country of interest, one path is through the authors' affiliations. In this case, it is necessary to use some scientific database that has the identification of the author's country as a filter. For example, the Scopus database defines the authors' country of affiliation and the option to include it in the search string.
7. **Remove duplicates and identify works using criteria defined in the title and abstract:** At this stage, duplicate papers should be removed, and inclusion/exclusion criteria should be applied by reviewing the title and abstract. If it is not sufficient to accurately identify the criteria when assessing the abstract, the paper should proceed to a content analysis in step nine.
8. **Retrieve and create (or update) a digital repository with the identified works:** This step involves creating a shared repository to store the selected works and control files with a list of all the works listed by the scientific databases.
9. **Apply inclusion/exclusion criteria defined (in all sections of works)**: In this step are applied the defined inclusion/exclusion criteria. Some sections can be targeted for this application, such as the section describing data collection and results. Note that some criteria may no longer make sense when analyzing the full texts, and others may emerge. If this happens, the defined criteria should be adjusted, and some initial steps may need to be repeated in searching for new works.
10. **Extract and organize data**: Finally, the ISPM practice found should be extracted. A spreadsheet with a list of practices can be created. Once described, it can be synthesized into categories (e.g., tools, techniques, competences, etc.).

7. Conclusion

The success of IS projects cannot be disassociated from the practices adopted by organizations to manage their projects. This work aimed to identify and systematize ISPM practice. For this purpose, an SLR was performed, focusing on the management of IS projects in Portugal.

During the application of the SLR protocol, 27 papers were selected and consequently reviewed. The review of the selected papers has made it possible to achieve the following contributions: the identification of ten categories of ISPM practice, the categorization of each reviewed paper according to the results presented, and also the presentation of summaries of these papers where ISPM practice in Portugal is detailed.

In our opinion, another important contribution comes from the experience and lessons learned from the execution of the SLR process presented and applied in this research. In this sense, the ten-step process, focused on identifying ISPM practice, can be useful for replication studies focusing on other countries or regions. This work can be a starting point for further, more comprehensive studies to understand different realities and thus create a more complete knowledge base about ISPM practice. As the main limitation, we can point out that this study focused on the research literature. In future studies, the gray literature should also be considered.

References

[1] W. B. Adeoti-Adekeye, "The importance of management information systems," *Library Review,* vol. 46, no. 5, pp. 318-327, 1997, doi: 10.1108/00242539710178452.
[2] J. Varajão, A. Trigo, and J. Barroso, "Motivations and Trends for IT/IS Adoption: Insights from Portuguese Companies," *International Journal of Enterprise Information Systems,* vol. 5, no. 4, pp. 34-52, 2009, doi: 10.4018/jeis.2009090203.
[3] N. Takagi and J. Varajão, "Success Management and Scrum for IS Projects – An Integrated Approach," in *Pacific Asia Conference on Information Systems*, 2021: Association for Information Systems, pp. 1-8.
[4] H. Benbya, N. Nan, H. Tanriverdi, and Y. Yoo, "Complexity and information systems research in the emerging digital world," *Management Information Systems Quarterly,* vol. 44, no. 1, pp. 1-17, 2020.
[5] J. Varajão, "The many facets of information systems (+ projects) success," *International Journal of Information Systems and Project Management,* vol. 6, no. 4, pp. 5-13, 2018, doi: 10.12821/ijispm060401.
[6] PMI, *A Guide to the Project Management Body of Knowledge: (PMBOK guide)*, 7th ed. Newtown Square, PA, US: Project Management Institute, 2021.
[7] J. Varajão, R. Colomo-Palacios, and H. Silva, "ISO 21500:2012 and PMBoK 5 processes in information systems project management," *Computer Standards & Interfaces,* vol. 50, no. 2017, pp. 216-222, Feb 2017, doi: 10.1016/j.csi.2016.09.007.
[8] J. Pereira, J. Varajão, and N. Takagi, "Evaluation of Information Systems Project Success – Insights from Practitioners," *Information Systems Management*, vol. 39, no. 2, pp. 138-155, 2022, doi: 10.1080/10580530.2021.1887982.
[9] N. Takagi and J. Varajão, "Success Management in Information Systems Projects – work-in-progress," in *Proceedings of the Portuguese Association for Information Systems Conference*, Porto, Portugal, 2020.
[10] L. Kappelman *et al.*, "The 2020 SIM IT issues and trends study," *MIS Quarterly Executive*, vol. 20, no. 1, pp. 69-107, 2021, doi: 10.17705/2msqe.000XX.
[11] A. Ribeiro and L. Domingues, "Acceptance of an agile methodology in the public sector," *Procedia Computer Science*, vol. 138, pp. 621-629, 2018/01/01/ 2018, doi: 10.1016/j.procs.2018.10.083.
[12] C. Tam, E. J. C. Moura, T. Oliveira, and J. Varajão, "The factors influencing the success of on-going agile software development projects," *International Journal of Project Management,* vol. 38, no. 3, pp. 165-176, 2020/04/01 2020, doi: 10.1016/j.ijproman.2020.02.001.
[13] I. Moura, C. Dominguez, and J. Varajão, "Information systems project team members: factors for high performance," *The TQM Journal,* vol. 33, no. 6, pp. 1426-1446, 2021, doi: 10.1108/TQM-07-2020-0170.
[14] F. Silva, H. Jerónimo, and P. Vieira, "Leadership competencies revisited: A causal configuration analysis of success in the requirements phase of information systems projects," *Journal of Business Research,* vol. 101, pp. 688-696, 2019/08/01 2019, doi: 10.1016/j.jbusres.2019.01.025.
[15] A. Cardoso, T. F. B. Silva, N. Takagi, C. Silva, and A. Micelli, "A value chain development model for the public sector," *Business Process Management Journal,* vol. 28, no. 5/6, pp. 1229-1250, 2022, doi: 10.1108/BPMJ-09-2021-0619.
[16] A. Paiva, J. Varajão, C. Domínguez, and P. Ribeiro, "Key aspects in the assessment of success in software development projects. Is there a relationship with what is considered in other industries?," *Interciencia,* Conference Paper vol. 36, no. 3, pp. 200-204, 2011.
[17] M. Laranjeira, A. Trigo, and J. Varajão, "Success of Software Development Projects in Portugal - preliminary results," in *Proceedings of the Portuguese Association for Information Systems Conference*, Lisbon, Portugal, 2019: Associação Portuguesa de Sistemas de Informação (APSI).
[18] N. Takagi and J. Varajão, "ISO 21500 and success management: an integrated model for project management," *International Journal of Quality & Reliability Management,* vol. 39, no. 2, pp. 408-427, 2022, doi: 10.1108/IJQRM-10-2020-0353.
[19] A. Botchkarev and P. Finnigan, "Complexity in the context of information systems project management," *Organisational Project Management,* vol. 2, no. 1, pp. 15-34, 2015, doi: 10.5130/opm.v2i1.4272.

[20] E. M. Shehab, M. W. Sharp, L. Supramaniam, and T. A. Spedding, "Enterprise resource planning: An integrative review," *Business Process Management Journal*, vol. 10, no. 4, pp. 359-386, 2004, doi: 10.1108/14637150410548056.
[21] H. Stadtler, "Supply Chain Management — An Overview," in *Supply Chain Management and Advanced Planning: Concepts, Models, Software, and Case Studies*, H. Stadtler and C. Kilger Eds. Berlin, Heidelberg: Springer Berlin Heidelberg, 2008, pp. 9-36.
[22] R. Chalmeta, "Methodology for customer relationship management," *Journal of Systems and Software*, Article vol. 79, no. 7, pp. 1015-1024, 2006, doi: 10.1016/j.jss.2005.10.018.
[23] S. F. King and T. F. Burgess, "Understanding success and failure in customer relationship management," *Industrial Marketing Management*, vol. 37, no. 4, pp. 421-431, 2008/06/01 2008, doi: 10.1016/j.indmarman.2007.02.005.
[24] M. Williams, T. Ariyachandra, and M. Frolick, "Business Intelligence- Success Through Agile Implementation," (in English), *Journal of Management & Engineering Integration*, vol. 10, no. 1, pp. 14-21, 2018-05-26 2017.
[25] A. Teixeira, T. Oliveira, and J. Varajão, "Evaluation of Business Intelligence Projects Success - a Case Study," *Business Systems Research*, Article vol. 10, no. 1, pp. 1-12, 2019, doi: 10.2478/bsrj-2019-0001.
[26] F. S. Cardoso, J. Varajão, and A. Carvalho, "The adoption of Big Data technologies-A challenge for National Statistics Offices," in *Americas Conference on Information Systems*, Montreal, CA, 2021.
[27] S. Dash, S. K. Shakyawar, M. Sharma, and S. Kaushik, "Big data in healthcare: management, analysis and future prospects," *Journal of Big Data*, vol. 6, no. 1, pp. 1-25, 2019/06/19 2019, doi: 10.1186/s40537-019-0217-0.
[28] P. Chakraborty, R. Shahriyar, A. Iqbal, and A. Bosu, "Understanding the software development practices of blockchain projects: a survey," in *ACM / IEEE International Symposium on Empirical Software Engineering and Measurement*, Oulu, Finland, 2018 2018, pp. 1-10, doi: 10.1145/3239235.3240298.
[29] M. Mignerat and S. Rivard, "The institutionalization of information system project management practices," *Information and Organization*, vol. 22, no. 2, pp. 125-153, 2012/04/01 2012, doi: 10.1016/j.infoandorg.2012.01.003.
[30] R. C. Mahaney and A. L. Lederer, "Information systems project management: an agency theory interpretation," *Journal of Systems and Software*, vol. 68, no. 1, pp. 1-9, 2003/10/15 2003, doi: 10.1016/S0164-1212(02)00132-2.
[31] F. Hartman and R. A. Ashrafi, "Project Management in the Information Systems and Information Technologies Industries," *Project Management Journal*, vol. 33, no. 3, pp. 5-15, 2002/09/01 2002, doi: 10.1177/875697280203300303.
[32] AXELOS, *Managing successful projects with PRINCE2*, Sixth ed. London: The Stationery Office, 2017.
[33] EU, *The PM² Project Management Methodology Guide 3.0.1*. Luxembourg, Brussels: European Union, 2021.
[34] *ISO 21502 - Project, programme and portfolio management — Guidance on project management*, ISO, Geneva, Switzerland, 2020.
[35] J. Varajão, C. Dominguez, P. Ribeiro, and A. Paiva, "Critical success aspects in project management: Similarities and differences between the construction and the software industry," *Tehnicki Vjesnik*, Article vol. 21, no. 3, pp. 583-589, 2014.
[36] A. Tereso, P. Ribeiro, G. Fernandes, I. Loureiro, and M. Ferreira, "Project Management Practices in Private Organizations," *Project Management Journal*, vol. 50, no. 1, pp. 6–22, 2019, doi: 10.1177/8756972818810966.
[37] A. Varshosaz, J. Varajão, and N. Takagi, "Integrating the Information Systems Success Model With Project Success Management Process," *International Journal of Applied Management Theory and Research*, vol. 3, no. 2, pp. 1-13, 2021, doi: 10.4018/IJAMTR.2021070101.
[38] J. Varajão and N. Takagi, "Information systems project managers technical competences – perceived importance and influencing variables," *International Journal of Business Information Systems*, vol. ahead-of-print, 2024, doi: 10.1504/IJBIS.2021.10039704.
[39] A. Liberati *et al.*, "The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration," *Journal of Clinical Epidemiology*, vol. 62, no. 10, pp. 1-34, 2009/10/01 2009, doi: 10.1016/j.jclinepi.2009.06.006.
[40] B. Kitchenham and P. Brereton, "A systematic review of systematic review process research in software engineering," *Information and Software Technology*, vol. 55, no. 12, pp. 2049-2075, 2013/12/01/ 2013, doi: 10.1016/j.infsof.2013.07.010.
[41] C. Okoli and K. Schabram, "A Guide to Conducting a Systematic Literature Review of Information Systems Research," *SSRN Electronic Journal*, vol. 10, no. 26, pp. 1-49, 2010, doi: 10.2139/ssrn.1954824.

[42] T. Meline, "Selecting Studies for Systemic Review: Inclusion and Exclusion Criteria," *Contemporary Issues in Communication Science and Disorders*, vol. 33, no. Spring, pp. 21-27, 2006/03/01 2006, doi: 10.1044/cicsd_33_S_21.
[43] J. Varajão, J. Cardoso, D. Gonçalves, and J. Cruz, "Análise à gestão de projectos de desenvolvimento de software em grandes empresas portuguesas," *Semana Informática*, vol. 904, pp. 10-12, 2008.
[44] M. Catarino, D. Gonçalves, A. Pereira, and J. Varajão, "Software projects' most important activities of quality management: A Delphi study," IBIMA, Marrakech, Morocco, 2009.
[45] J. S. Rodrigues, A. R. Costa, and C. G. Gestoso, "National Culture and Planning and Control of Projects in Portugal," presented at the International Congress on Project Management and Engineering, Alcañiz, Spain, 2014. [Online]. Available: 10.1007/978-3-319-26459-2_5.
[46] J. Varajão, C. Dominguez, P. Ribeiro, and A. Paiva, "Failures in software project management - are we alone? A comparison with construction industry," *Journal of Modern Project Management*, Article vol. 2, no. 1, pp. 22-27, 2014.
[47] J. Varajão and A. Trigo, "Evaluation of IS project success in InfSysMakers: an exploratory case study," *International Conference on Information Systems*, Dublin-Ireland, 2016.
[48] T. M. Fernandes, J. Gomes, and M. Romão, "Investments in E-Government: A benefit management case study," *International Journal of Electronic Government Research*, vol. 13, no. 3, pp. 1-17, 2017, doi: 10.4018/IJEGR.2017070101.
[49] L. Silva, J. Varajão, C. Dominguez, and I. Moura, "Motivations for high performance teams of information systems projects," in *Proceedings of the Portuguese Association for Information Systems Conference*, Guimarães, Portugal, 2017: Associação Portuguesa de Sistemas de Informação, doi: 10.18803/capsi.v17.00-00.
[50] J. Varajão, L. Magalhães, L. Freitas, P. Ribeiro, and J. Ramos, "Implementing Success Management in an IT project," *Procedia Computer Science*, vol. 138, no. 2018, pp. 891–898, 2018, doi: 10.1016/j.procs.2018.10.116.
[51] J. Varajão and J. A. Carvalho, "Evaluating the Success of IS/IT Projects: How Are Companies Doing It?," presented at the International Research Workshop on IT Project Management, 2018.
[52] I. Moura, C. Dominguez, and J. Varajão, "Information systems project teams: factors for high performance," *Team Performance Management: An International Journal*, vol. 25, no. 1/2, pp. 69-83, 2019, doi: 10.1108/TPM-03-2018-0022.
[53] J. Varajão, H. Silva, and M. Pejic-Bach, "Key Competences of Information Systems Project Managers," *International Journal of Information Technology Project Management*, vol. 10, no. 4, pp. 73-90, 2019, doi: 10.4018/IJITPM.2019070105.
[54] J. Varajão, G. Fernandes, and H. Silva, "Most used project management tools and techniques in information systems projects," *Journal of Systems and Information Technology*, vol. 12, no. 3, pp. 225-242, 2020, doi: 10.1108/JSIT-08-2017-0070.
[55] A. Gonçalves, P. M. Oliveira, and J. Varajão, "Success Factors of Information Systems Projects in Portuguese Public Institutions," *Portuguese Association for Information Systems Conference*, Vila Real/Leiria, Portugal, 2021.
[56] J. Varajão and A. Amaral, "Risk Management in Information Systems Projects: It Can Be Risky Not To Do It," *International Journal of Project Management and Productivity Assessment*, vol. 9, no. 1, pp. 1-10, 2021, doi: 10.4018/IJPMPA.20210101.oa.
[57] J. Varajão, A. Trigo, J. L. Pereira, and I. Moura, "Information systems project management success," *International Journal of Information Systems and Project Management*, vol. 9, no. 4, pp. 62-74, 2021, doi: 10.12821/ijispm090404.
[58] R. Colomo-Palacios, I. González-Carrasco, J. L. López-Cuadrado, A. Trigo, and J. Varajão, "I-Competere: Using applied intelligence in search of competency gaps in software project managers," *Information Systems Frontiers*, vol. 16, no. 4, pp. 607-625, 2014, doi: 10.1007/s10796-012-9369-6.
[59] F. Escobar, J. Varajão, N. Takagi, and U. A. Neto, "Multi-criteria model for selecting project managers in the public sector," *International Journal of Information and Decision Sciences*, vol. 14, no. 3, pp. 205-242, 2022/01/01 2022, doi: 10.1504/IJIDS.2022.125168.
[60] J. Varajão, A. Trigo, and L. Rodrigues, "Gestão de Projetos de Sistemas de Informação: Realidades e Tendências," in *Sistemas de Informação: Diagnósticos e Prospectivas*: Sílabo, 2022.

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